ICOM

SERVICE MANUAL

IC-28A/E/H

ICOM INCORPORATED

144MHz FM TRANSCEIVER

IC-28A/E/H

SERVICE MANUAL

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FOREWORD

Thank you for selecting ICOM's versatile **IC-28A/E/H**, one of the finest FM mobile transceivers on the market today.

Sophisticated in design, yet light, compact, and easy to operate, the **IC-28A/E/H** benefits from the latest in ICOM engineering techniques and from ICOM's established leadership in the communications field.

The picture shows the IC-28A version.

ASSISTANCE

Four separate versions of the **IC-28A/E/H** have been designed for use in the U.S.A., Europe, Australia, and in Spain and Italy. This service manual covers every version. When using the manual each model can be referred to by the following assigned version numbers:

#01 U.S.A. version
#03 EUROPE version
#04 AUSTRALIA version
#05 SPAIN, ITALY versions

If you require assistance or information regarding the operation and capabilities of the **IC-28A/E/H**, please contact your nearest authorized ICOM Dealer or ICOM Service Center.

TABLE OF CONTENTS

SECTION 1 SPECIFICATIONS

1 - 1 GENERAL

Frequency coverage

MODEL	GUARANTEED RANGE	OPERATIONAL RANGE	
	TRANSCEIVER	RECEIVER	TRANSMITTER
IC-28A U.S.A. version	144.00 ~ 148.00	138.00 ~ 174.00	140.10 ~ 150.00
IC-28E Europe version	144.00 ~ 146.00	144.00 ~ 146.00	144.00 ~ 146.00
IC-28A Australia version	144.00 ~ 148.00	144.00 ~ 148.00	144.00 ~ 148.00
IC-28E Spain, Italy versions	144.00 ~ 148.00	140.00 ~ 150.00	140.00 ~ 150.00

NOTE: Ranges are identical for the IC-28H model.

Frequency resolution : U.S.A., Australia versions 5, 10, 15, 20 or 25kHz (programmable)
Europe, Italy, Sapin versions 12.5 or 25kHz (programmable)

Frequency control : CPU based 5kHz (or 6.25kHz) step digital PLL synthesizer
Simplex and semi-duplex capability (programmable offset)

Memory channels : 21 channels

Usable temperature range : −10°C ~ +60°C (+14°F ~ +140°F)

Power supply requirement : 13.8V DC±15% (negative ground)
AC power supply is available for AC operation.

Current drain (at 13.8V DC) : Transmit

(IC-28A/E versions)

HIGH (25W)	Approx.	6.0A
LOW (5W)	Approx.	3.0A

Receive

Max. audio output	Approx.	800mA
Squelched	Approx.	450mA

(IC-28H version) : Transmit

HIGH (45W)	Maximum	9.5A
LOW (5W)	Approx.	3.5A

Receive

Max. audio output	Approx.	800mA
Squelched	Approx.	450mA

Antenna impedance : 50 ohms unbalanced

Dimensions : 140(140)mm(W) × 50(50)mm(H) × 133(148.5)mm(D)
Bracketed values include projections

Weight : 0.95kg (IC-28A/E versions)
: 1.2kg (IC-28H version)

1 - 2 TRANSMITTER

(IC-28A/E versions)

Output power : HIGH 25W LOW 5W

Emission mode : 16K0F3E

Modulation system : Variable reactance frequency modulation

Max. frequency deviation : ±5.0kHz

Spurious emissions : More than 60dB below carrier

Microphone : 600 ohm electret condenser with Push-To-Talk and scanning switches (Europe, Spain, and Italy versions include a 1750Hz TONE BURST SWITCH)

(IC-28H version)

Output power	:	HIGH 45W LOW 5W
Emission mode	:	16K0F3E (16K0F2D: When operating with an optional UT-28)
Modulation system	:	Variable reactance frequency modulation
Max. frequency deviation	:	±5.0kHz
Spurious emission	:	More than 60dB below carrier
Microphone	:	600 ohm electret condenser with Push-To-Talk and scanning switches (Europe, Spain, and Italy versions include a 1750Hz TONE BURST SWITCH)

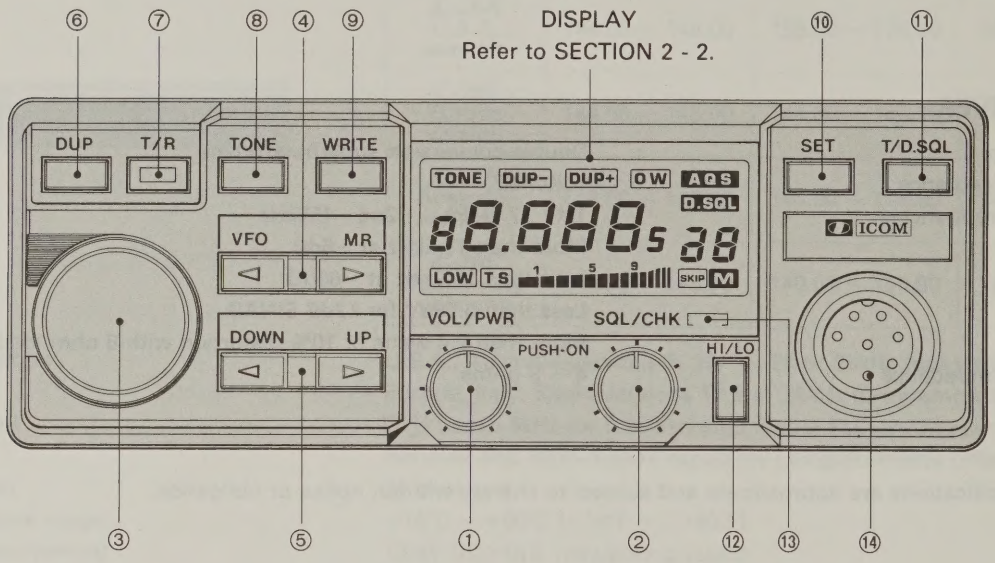
1 - 3 RECEIVER

Receive system	:	Double-conversion superheterodyne
Modulation acceptance	:	16K0F3E
Intermediate frequencies	:	1st 17.2MHz 2nd 455kHz
Selectivity	:	More than 12.5kHz at −6dB Less than 25.0kHz at −60dB
Sensitivity	:	Less than 0.18μV for 12dB SINAD
Audio output	:	More than 2.4 watts at 10% distortion with 8 ohm load
Audio output impedance	:	4 ~ 8 ohms

All stated specifications are approximate and subject to change without notice or obligation.

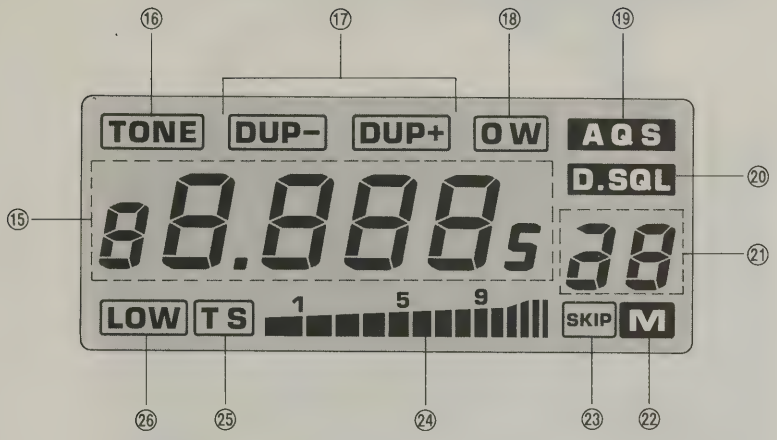
SECTION 2 OUTSIDE AND INSIDE VIEWS

2 - 1 FRONT PANEL



① VOLUME CONTROL/POWER SWITCH [VOL/PWR]
② SQUELCH CONTROL/CHECK SWITCH [SQL/CHK]
③ TUNING CONTROL
④ VFO/MEMORY READ SWITCH [VFO/MR]
⑤ DOWN/UP SWITCH [DOWN/UP]
⑥ DUPLEX SWITCH [DUP]
⑦ TRANSMIT/RECEIVE INDICATOR [T/R]
⑧ TONE SWITCH [TONE] (U.S.A. version)
CALL SWITCH [CALL] (Australia, Europe, Spain, Italy versions)
⑨ WRITE SWITCH [WRITE]
⑩ SET SWITCH [SET]
⑪ TONE SQUELCH SWITCH/DIGITAL SQUELCH SWITCH [T/D. SQL]
⑫ HIGH/LOW SWITCH [HI/LO]
⑬ DISPLAY DIMMER SENSOR
⑭ MIC CONNECTOR

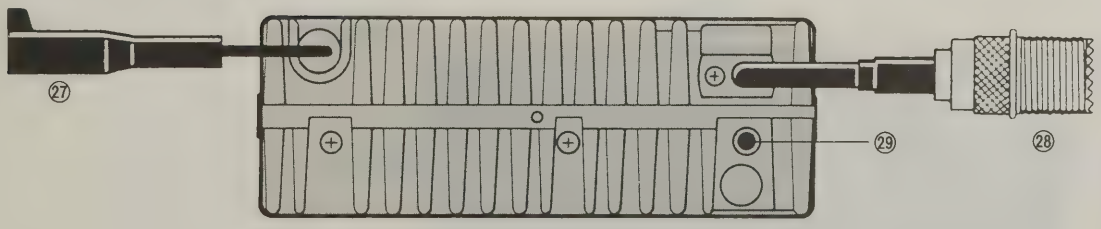
2 - 2 DISPLAY



⑮ FREQUENCY
⑯ SUBAUDIBLE TONE INDICATOR "TONE"
⑰ DUPLEX MODE INDICATORS "DUP–, DUP+"
⑱ OFFSET WRITE INDICATOR "OW"
⑲ GROUP CODE INDICATOR "AQS"
⑳ SQUELCH SYSTEM INDICATOR "D. SQL"
㉑ MEMORY CHANNEL NUMBER
㉒ MEMORY MODE INDICATOR "M"
㉓ MEMORY CHANNEL SKIP INDICATOR "SKIP"
㉔ S/RF INDICATOR
㉕ TUNING STEP INDICATOR "TS"
㉖ OUTPUT POWER INDICATOR "LOW"

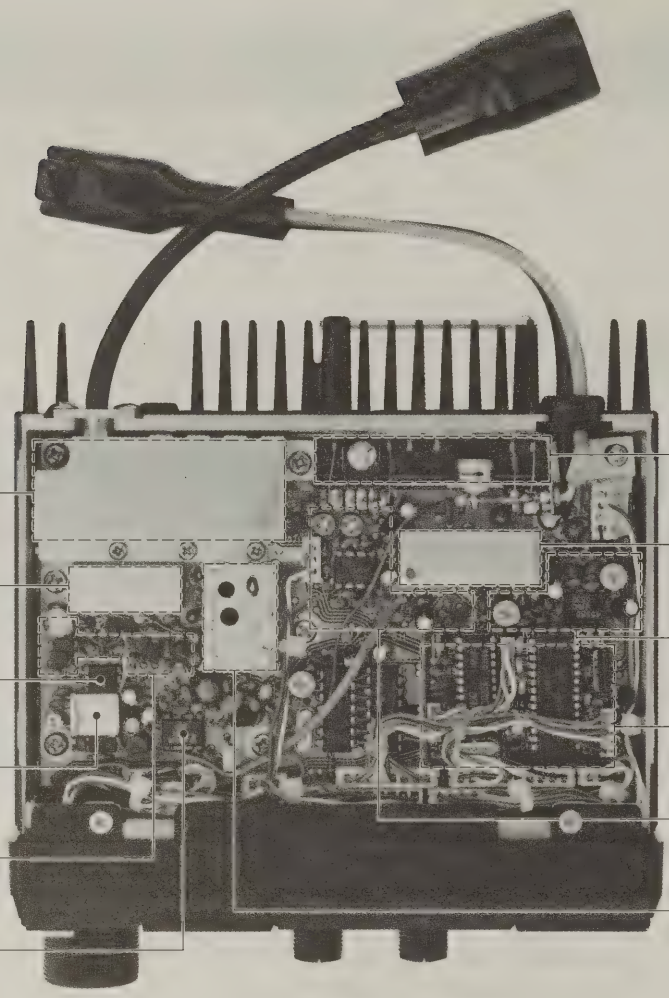
AQS refers to Amateur Quinmatic System which includes digital code squelch as one feature. The digital code squelch used in AQS is not compatible with some other commercially available digital squelch systems.

2 - 3 REAR PANEL



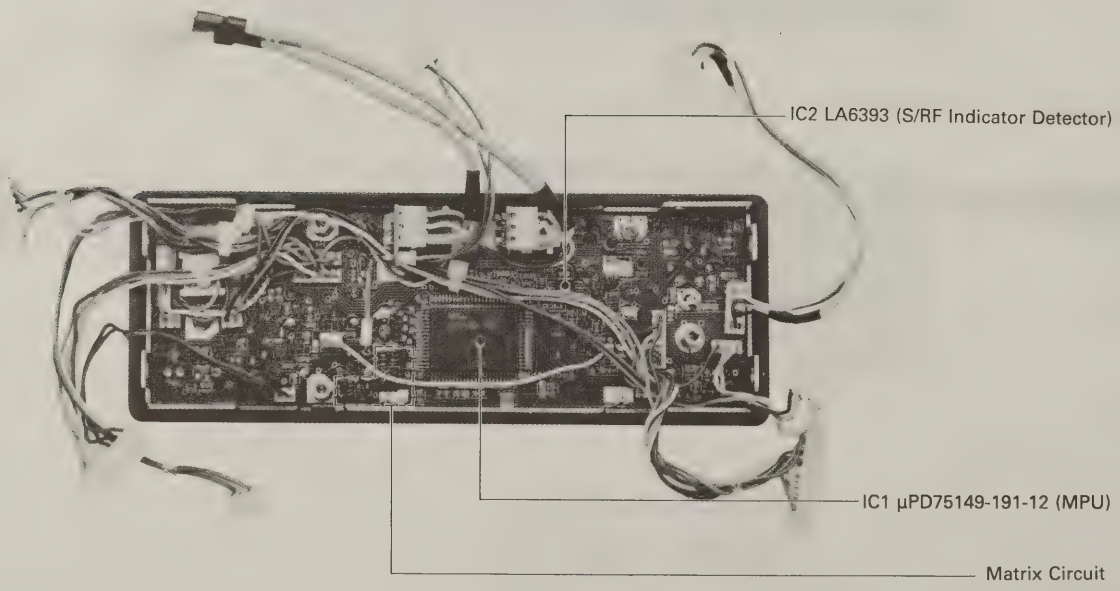
㉗ POWER CONNECTOR
㉘ ANTENNA CONNECTOR
㉙ EXTERNAL SPEAKER JACK

2 - 4 MAIN UNIT

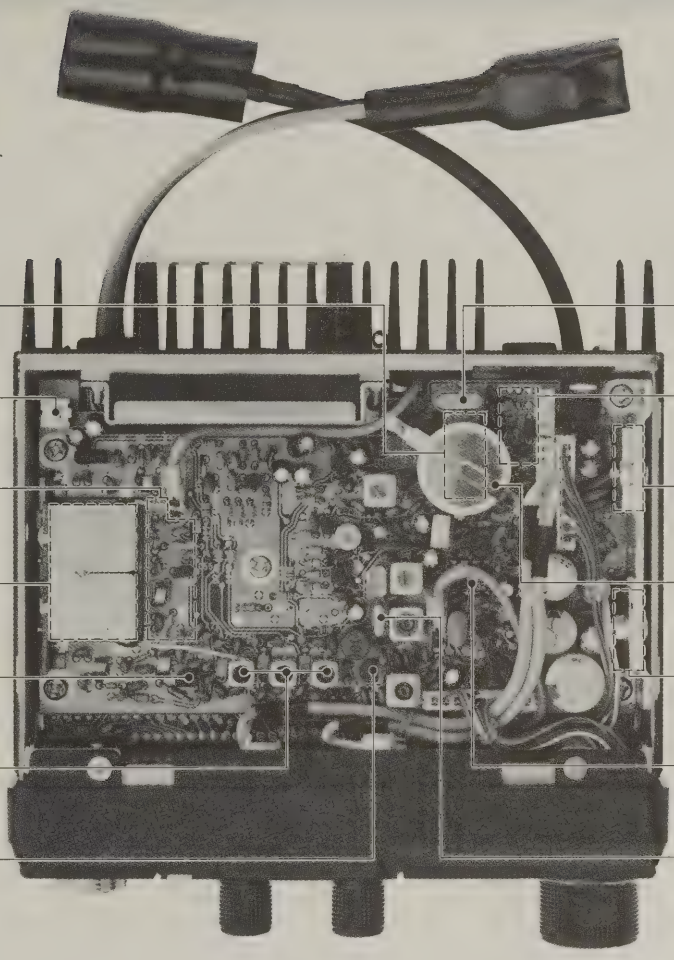


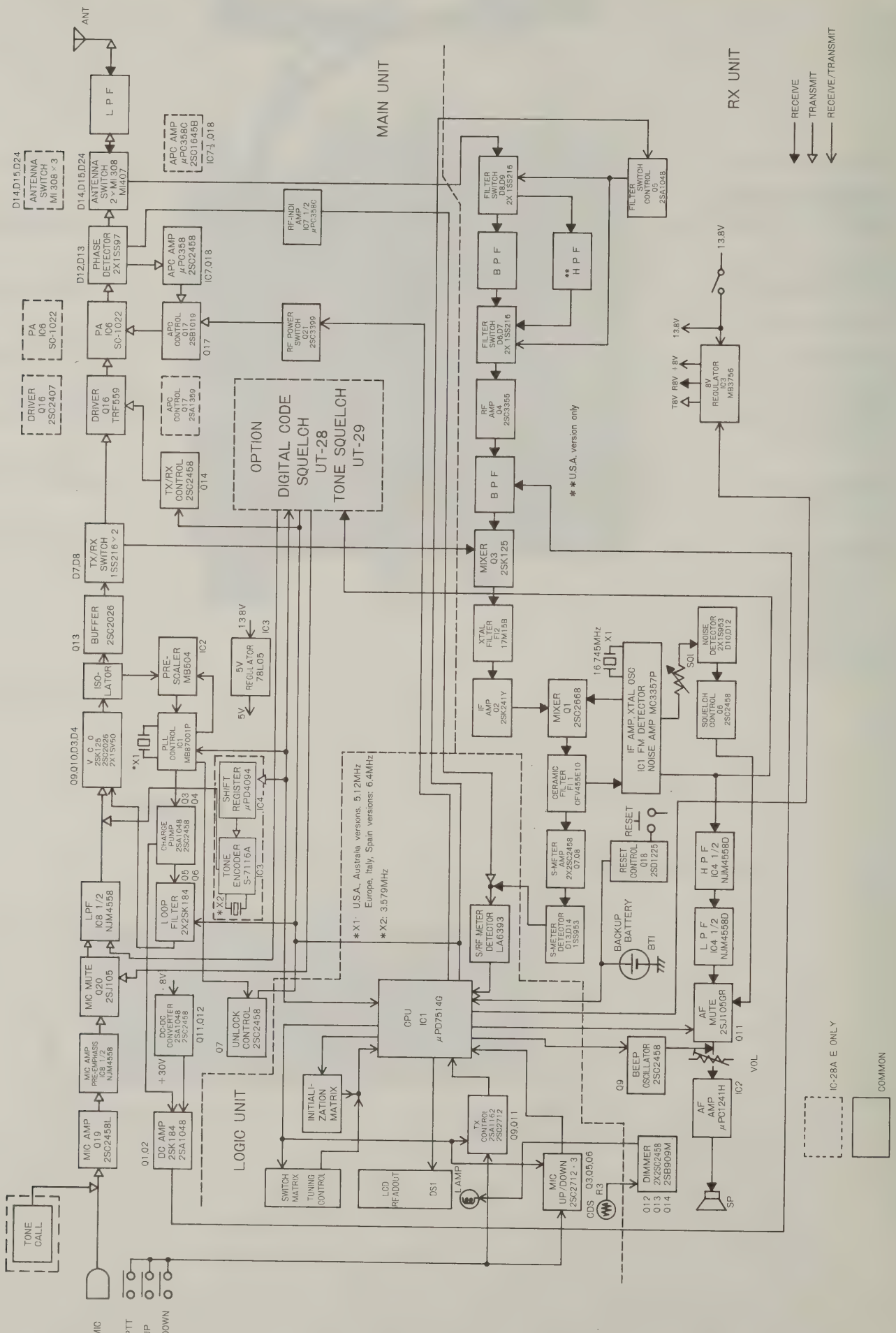
*IC-28H version:
IC1 MB87001P-G
IC2 MB504P-G
IC6 SC-1022
Q16 TRF559
X1 CR106 (#01, #04)
CR107 (#03, #05)

2 - 5 EF UNIT



2 - 6 RX UNIT


IC1 MC3357P (IF Circuit IC)
CPU Reset Switch (To reset malfunctioning CPU, turn ON IC-28A/E/H and push RESET SWITCH)
Out-of-Band Bandpass Filter Circuit
RF Bandpass Filter Circuit
Q4 2SC3355 (1ST RF Amplifier Circuit)
Receive Bandpass Filter
Q3 2SK125 (1ST Mixer)
X2 CR166 (2ND LO Crystal) 16.745MHz
Squelch Detector Circuit
IC3 MB3756 (9V Regulator IC)
BT1 BR2032-1T2 (Backup Lithium Battery)
IC2 μPC1241H (AF Power Amplifier)
IC4 NJM4558D (AF Pre-Amplifier)
F12 17M15B (Crystal Filter)


MAIN UNIT
RX UNIT
LOGIC UNIT
OPTION
DIGITAL CODE SQUELCH UT-28
TONE SQUELCH UT-29
RECEIVE
TRANSMIT
RECEIVE/TRANSMIT
IC-28A E ONLY
COMMON
ANT
L P F
ANTENNA SWITCH MI 308 × 3
ANTENNA SWITCH 2 × MI 308 MI407
PHASE DETECTOR 2X1SS97
APC AMP μPC358 2SC2458
APC AMP μPC358C 2SC1645B
RF-INDI AMP μPC3586
PA IC6 SC-1022
APC CONTROL 2SB1019
RF POWER SWITCH 2SC3399
DRIVER Q16 2SC2407
DRIVER Q16 TRF559
APC CONTROL 2SA1359
TX/RX CONTROL 2SC2458
TX/RX SWITCH 1SS216 × 2
BUFFER 2SC2026
ISO-LATOR
PRE-SCALER MB504
PLL CONTROL MB87001P
V C O 2SK125 2SC2026 2X1SV60
5V REGULATOR 78L05
13.8V
5V
*X1
*X2
*X1: USA, Australia versions: 5.12MHz
Europe, Italy, Spain versions: 6.4MHz
*X2: 3.579MHz
SHIFT REGISTER μPD4094
TONE ENCODER S-7116A
CHARGE PUMP 2SK184 2SC2458
LOOP FILTER 2X2SK184
LPF IC8 1/2 NJM4558
MIC MUTE Q20 2SJ105
MIC AMP PRE-EMPHASIS IC8 1/2 NJM4558
MIC AMP Q19 2SC2458L
DC-DC CONVERTER 2SK184 2SC2458
DC AMP 2SK184 2SA1048
+30V
8V
UNLOCK CONTROL 2SC2458
INITIALI-ZATION MATRIX
SWITCH MATRIX
TUNING CONTROL
LCD READOUT
DS1
LAMP
TX CONTROL 2SC2712 2SC2712
MIC UP/DOWN 2SC2712 - 3
DIMMER 2X2SC2458 2SB909M
CDS R3
CPU IC1 μPD75514G
BEEP OSCILLATOR 2SC2458
AF MUTE 2SJ105GR
AF AMP μPC1241H
SP
VOL
S/RF METER DETECTOR LA6393
S-METER AMP 2X2SC2458
S-METER DETECTOR 1SS953
RESET CONTROL 2SD1225
BACKUP BATTERY
BT1
H P F IC4 1/2 NJM4558D
L P F IC4 1/2 NJM4558D
CERAMIC FILTER CFV455E10
IF AMP XTAL OSC FM DETECTOR NOISE AMP MC3357P
16.745MHz
SQUELCH CONTROL 2SC2458
NOISE DETECTOR 2X1SS953
MIXER Q1 2SC2668
IF AMP Q2 2SK241Y
XTAL FILTER FI2 17M19B
MIXER Q3 2SK125
B P F
RF AMP Q4 2SC3356
FILTER SWITCH DIODE 2X1SS216
FILTER SWITCH CONTROL Q5 2SA1048
** H P F
13.8V
8V REGULATOR IC3 MB3756
T8V R8V +8V
** U.S.A. version only
MIC
PTT
UP
DOWN
TONE CALL

4 - 1 RECEIVER CIRCUITS

4 - 1 - 1 RF CIRCUIT

Signals from the antenna are fed to the RX UNIT through a constant K pie-type filter on the MAIN UNIT. In the amateur band an RF circuit having good intermodulation characteristics is created by using a bandpass filter (consisting of L11 and L10) that eliminates nearby amateur band signals. When operating out of the amateur band the RF circuit has a broad bandpass filter which uses a high pass filter (consisting of C48, L13, C47) and a constant K pie-type filter. The RF circuit is then free of variance on any frequency from 138 ~ 174MHz.

Switching between bandpass filters in and out of the amateur band is controlled by a signal from the LOGIC UNIT. This signal activates Q5 which turns ON and OFF a quarter-wave diode switch that is connected to the input and output of the bandpass filter.

Signals amplified by Q4 are fed to three-stage variable resonators consisting of coils L8, L7 and L6, and diodes D4, D3, and D2 to eliminate unwanted out-of-frequency signals and to obtain good receiver selectivity.

The control voltage for varactor diodes D4, D3 and D2 is supplied by the VCO UNIT through a buffer amplifier. This amplifier requires high voltage, so a DC-DC converter circuit is used to supply 30V DC to the buffer amplifier.

4 - 1 - 2 IF CIRCUIT

Signals from the BPF are passed into Q3 and are mixed with a 1st LO signal to convert the IF signal to 17.2MHz. The 1st LO signal is fed into R14 on the RX UNIT by applying R8V to a diode switch on the MAIN UNIT.

The 1st IF signal mixed by Q3 is fed to a matching circuit consisting of L3 and is fed to FI2, a high-shaped factor crystal filter designed to accept only the object signal and to eliminate any unwanted signals.

The 1st IF signal passed through the filter is fed to a matching circuit consisting of L2, and is amplified by Q2, the 1st IF amplifier. The amplified signal is fed to Q1, the 2nd mixer circuit, to obtain the 2nd IF frequency (455kHz) with a 2nd LO signal generated by an oscillator circuit in IC1 and crystal X2.

The 2nd IF signal is fed to a high-performance ceramic filter, FI1, to eliminate unwanted signals and is amplified by a limiter amplifier in IC1. The amplified signal is fed to an FM detector circuit in IC1 using quadrature detection to get audio signals. This IF circuit creates a non-adjustment circuit using a phase-delay element with an X1 ceramic discriminator.

4 - 1 - 3 AF CIRCUITS

Audio signals from IC1 are amplified by a noise amplifier circuit in IC1 through the SQUELCH CONTROL on the front panel. A noise detector circuit consisting of D10 and D12 detects noise components and controls Q6 to receive the squelch control signal. This control signal is applied to Q10, turning ON and OFF Q11, the analog switch circuit, and to Q17. This action controls the IC2 AF amplifier which emits no audio output, including noise output, when no signal is received.

The audio signal from IC1 is fed to IC4 for deemphasis as well as for subaudible tone audio reduction from the speaker when the TONE SQUELCH function is being used. This audio signal is applied to the IC2 AF amplifier through the Q11 analog switch circuit and the VOLUME CONTROL on the front panel. The signal is amplified by IC2 and drives the internal or external speaker.

Q11 functions as a muting circuit using an analog switch to block the audio signal to IC2. An AF MUTE signal is obtained by the SQUELCH CONTROL or when the transceiver is in transmit mode. Q17 blocks leakage of the audio signal on the pin 1 line of IC2 when Q11 is activated.

When the beep oscillator is activated, Q16 controls Q17 and the beep signal is applied to IC2. If SWITCHES such as [DUP], [TONE], [WRITE], [VFO], [MR] and [SET] on the front panel are pushed, a parallel R-type phase oscillator using Q9 is activated by a signal from the CPU, emitting a beep sound. At this time, Q11 is activated and only the beep sound is emitted from the speaker.

4 - 1 - 4 S-METER CIRCUIT

S-meter signals are created by 2nd IF signals which are passed through FI1 and amplified by Q7 and Q8, the S-meter amplifier circuit. The 2nd IF signals are then fed to D13 and D14 where they are rectified, obtaining DC signals for the S-meter signal. The S-meter signal is then added to the RF-meter signal and this signal drives the bar indicator on the FREQUENCY DISPLAY through the LCD driver in the CPU.

4 - 1 - 5 AUTOMATIC DIMMER CIRCUIT

This circuit consists of Q12, Q13, Q14 on the RX UNIT and a photo sensor, R3 (CDS) on the EF UNIT. The CDS alters DISPLAY brightness according to variation of current. The current is amplified by Q14 and drives Q12 and Q13. The brightness of the FREQUENCY DISPLAY changes continuously via C113.

4 - 1 - 6 VOLTAGE REGULATOR CIRCUITS

The 13.8V line which passes through the POWER SWITCH on the front panel is applied to IC3 on the RX UNIT. IC3 is a voltage regulator with a selector switch IC chip for applying a constant 8V, R8V during receiving, and T8V during transmitting.

4 - 1 - 7 CPU RESET CIRCUIT

S1 and Q19 reset the CPU. If the CPU should malfunction, push the RESET SWITCH to reset it (See page 2 - 4 for the RESET SWITCH location on the RX UNIT). At this time, the CPU is initialized. Q18 prevents the transceiver from reverting to transmit mode when the CPU is being reset. The reset function only operates when the transceiver is ON.

4 - 2 TRANSMITTER CIRCUIT

4 - 2 - 1 MIC AMPLIFIER CIRCUIT

Audio signals from the microphone are fed into Q19, the first mic amplifier circuit, on the MAIN UNIT. After passing through this circuit, the signals are fed into IC8(A), the limiter amplifier circuit. This circuit has preemphasis characteristics between 300Hz and 3kHz with 6dB/octave.

Output signals from the limiter amplifier pass through Q20, the mic mute circuit, and are fed into IC8(B), the active low-pass filter circuit. The rectangular waveform of the limiter amplifier output contains many harmonics. Harmonics which are 3kHz or higher are eliminated by IC8(B).

These filtered signals are applied to the VCO to modulate the frequency and produce an FM signal. R100 is a variable resistor for adjusting deviation.

4 - 2 - 2 BUFFER AND DRIVE CIRCUITS

Signals generated at the VCO circuit are buffered at Q10, and passed through an isolating circuit consisting of L6, C24 and R30 to R32. After passing through the isolating circuit, signals are buffered and amplified at Q13 and applied to the driver amplifier circuit through switching circuit, D7 and D8. The driver amplifies the signal to a suitable level for the power amplifier.

4 - 2 - 3 POWER AMPLIFIER CIRCUIT

Output signals from the driver amplifier are fed into the power amplifier module, IC6, and output 25 watts (A/E version) or 45 watts (H version). The output signal of IC1 is applied to the ANTENNA CONNECTOR through the T/R switching circuit, D14, and the low pass filter.

4 - 2 - 4 ALC (Automatic Level Control) and RF POWER METER CIRCUITS

The output voltage level of the ALC detector circuit (D12, D13 and L14) is a minimum value when the antenna impedance is matched at 50 ohms. However, when the antenna impedance is in a mismatched condition, the detector voltage becomes higher than it would be if the antenna were matched.

The detector voltage is applied to the APC amplifier circuit, IC7(A). Output of IC7(A) controls the Q18 bias voltage, which in turn controls the total gain of the power amplifier (IC6) through Q17. R71 is the HIGH Power adjustment point while R72 is the LOW Power adjustment point. Both variable resistors control the amp gain of the APC Amplifier, IC7(A).

The detector voltage is also used for the RF meter. This voltage is applied to pin 5 of IC7(B), is amplified, and then is applied to IC2, the S/RF meter detector circuit, on the EF UNIT.

4 - 3 PLL CIRCUITS

4 - 3 - 1 DUAL MODULUS PRESCALER

The PLL is designed in a way that allows the desired frequency to be generated directly by the VCO, adopting a dual modulous prescaler system. The PLL consists of a prescaler (IC2) and PLL IC (IC1). It is fed "divided by N-data" from the MPU which determines the operating frequency.

N-data is determined by dividing the desired frequency by the reference frequency. The desired frequency is the transmit frequency in the transmit mode and the first local oscillator frequency in the receive mode.

$$N = \frac{\text{Desired frequency}}{\text{Reference frequency}}$$

A reference frequency of 5kHz (#01, #04) or 12.5kHz (#03, #05) is acquired by X1 and the divider inside IC1. A signal from the VCO that is buffer amplified at Q10 is fed into IC2 and divided N-times through the local oscillator switching circuit (D7, D8). The divided signal at IC2 is applied to IC1 and phase detected, resulting in lock voltages being output from pins 9 and 10. Output voltages are applied to varactor diodes D3 and D4 to control the VCO frequency through the charge pump and the loop filter. Due to a no-multiplying mixing circuitry, the circuit constitution is simple and reduces spuriousness.

4 - 3 - 2 LOOP FILTER CIRCUIT

Output from pins 9 and 10 of IC1 is fed into a charge pump (Q3 and Q4) and is then applied to a lag lead-type loop filter (R6, R11, R13, C1 ~ C4).

The PLL time constant switching circuit (Q5, Q6) reduces the resistance of R6 to shorten the PLL lock up time. When the frequency or transmit/receive mode is being changed, pin 7 of IC1 is at "LOW", Q7 is "OPEN", and Q5 and Q6 are activated.

To create wide-band oscillation characteristics in the VCO, a high voltage is applied to the charge pump. Q11 and Q12 comprise a DC-DC converter circuit which generates approximately 30V.

4 - 3 - 3 VCO CIRCUIT

The VCO, Q9, employs a Hartley Oscillator Circuit. This oscillator circuit has no shift circuit, so lock voltages which come from N-data control the entire frequency range. An output signal from the VCO is buffer amplified at Q10 and passes through the isolation circuit, L6.

4 - 4 LOGIC CIRCUITS

Logic circuits are installed in the EF UNIT. The EF UNIT is located behind the front panel and controls receiver and transmitter sections as well as all switch functions on the front panel.

The EF UNIT includes a one-chip microcomputer CPU, NEC µPD7514G. This chip contains a 4-bit parallel processing ALU, an ROM, RAM, I/O ports, 8-bit serial interface, 8-bit programmable timer/event counter, and LCD controller/driver. It operates as an independent unit.

The following explanations are CPU descriptions for all functions related to the CONTROLS and SWITCHES on the front panel of the IC-28A/E/H.

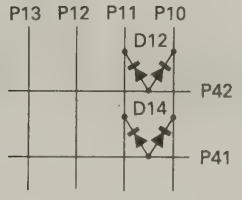
4 - 4 -1 CPU PORT ALLOCATIONS

PORT NUMBER	DESCRIPTION
P00	Interrupt input. Processor enters STOP mode.
P01	Outputs serial CK signals for PLL, tone encoder and optional UT-28 or UT-29.
P02	Outputs serial DATA signals for PLL, tone encoder and optional UT-28 or UT-29.
P03	Operating frequency range of each version expands when this port is "HIGH".
P10 ~ P13	Input ports for the matrix circuit. Refer to page 4 - 4 for explanation of the matrix circuit.
P20	Output port for a strobe signal of the PLL N-data.
P21	Output port for a strobe signal of the built-in CTCSS encoder N-data.
P22	No function.
P30	This port becomes "HIGH" when a beep sound is emitted.
P31	This port becomes "LOW" for the SEND line when the transceiver is in the transmit mode.
P32	This port becomes "LOW" when low power output is selected.
P33	This port becomes "HIGH" when the Digital Code Squelch is turned ON.
P40	This port is for LCD control and becomes "HIGH" when the transceiver is turned OFF.
P41 ~ P53	These ports are for matrix output.
P60	This is a data input port for the S-INDICATOR and RF-INDICATOR. Refer to SECTION 4 - 4 -3 for further information.
P61	This port outputs the RESET signal for the sub-CPU, and becomes "HIGH" for about 40µsec when the transceiver is initialized.
P62	This port becomes "HIGH" if the displayed frequency is out of band.
P63	This port becomes "HIGH" when AQS commands are sent to the sub-CPU in the AQS system.
P70	No function.
P71 ~ P73	These are data output ports for the S-INDICATOR and RF-INDICATOR. Refer to SECTION 4-4-3 for further information.
INT1	This is an input port for the Data Transmit Ready signal during communication with the sub-CPU for the AQS system, and is also an input port for the Group Number Verification signal when port P33 is "HIGH".

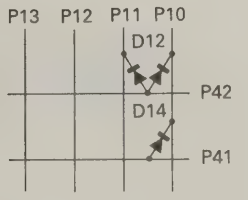
4 - 4 - 2 MATRIX PORT ALLOCATIONS

PORT NUMBER	DESCRIPTION
P41 ⟷ P10 ~ P13	This flow sets a band width.
P42 ⟷ P10	This flow sets the IF shift direction in receive mode. When the flow is activated, the IF shift selects (−) direction.
P42 ⟷ P11	This flow sets the IF frequency. When the flow is activated, the IF frequency is selected at 17.2MHz.
P42 ⟷ P12	No function.
P43 ⟷ P10	This flow activates the [SET] SWITCH function.
P43 ⟷ P11	These are squelch signal ports. When the SQLS line becomes "HIGH", Q4 is switched ON.
P43 ⟷ P12	These are input ports for the microphone UP/DOWN clock (CK) signals. Q4 is switched ON while either the UP or DOWN SWITCH on the microphone is pushed.
P43 ⟷ P13	These are input ports for the microphone UP/DOWN signals. Q5 is switched ON while the UP SWITCH on the microphone is pushed.
P50 ⟷ P10	These ports are used in the Japanese IC-28 version.
P50 ⟷ P11	These are input ports for the [VFO] SWITCH, and change the mode from memory mode to VFO mode.
P50 ⟷ P12	These are input ports for the [MR] SWITCH, and change modes from the VFO mode to memory mode.
P51 ⟷ P10, P11	These are input ports for the UP/DOWN signals on the MAIN DIAL.
P51 ⟷ P12, P13	These are input ports for the [DOWN/UP] SWITCH.
P52 ⟷ P10	These are input ports for the [HI/LO] SWITCH. They control output power when the transceiver is in LOW and switch the front panel "LOW" indicator ON or OFF.
P52 ⟷ P11	This flow creates the transmit condition. When the [PTT] SWITCH is pushed and the PTT1 line is "LOW", Q11 is switched OFF and Q9 is switched ON. In addition, the SEND line becomes "HIGH" when this matrix flow is activated.
P52 ⟷ P12	No function.
P53 ⟷ P13	These are input ports for the [WRITE] SWITCH.
P53 ⟷ P10	No function.
P53 ⟷ P11	When the optional UT-28 is installed, this matrix flow is activated and the SEL1 line becomes "LOW", switching Q10 ON.
P53 ⟷ P12	When the optional UT-29 is installed, this matrix flow is activated and the SEL2 line becomes "LOW", switching Q13 ON.
P53 ⟷ P13	These are input ports for the [SQL] SWITCH.

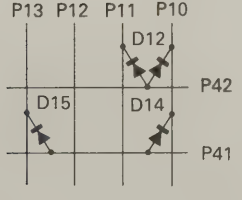
IC-28A/H
(USA VERSIONS)



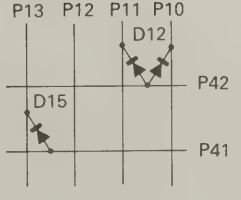
IC-28A/H
(AUSTRALIA VERSIONS)



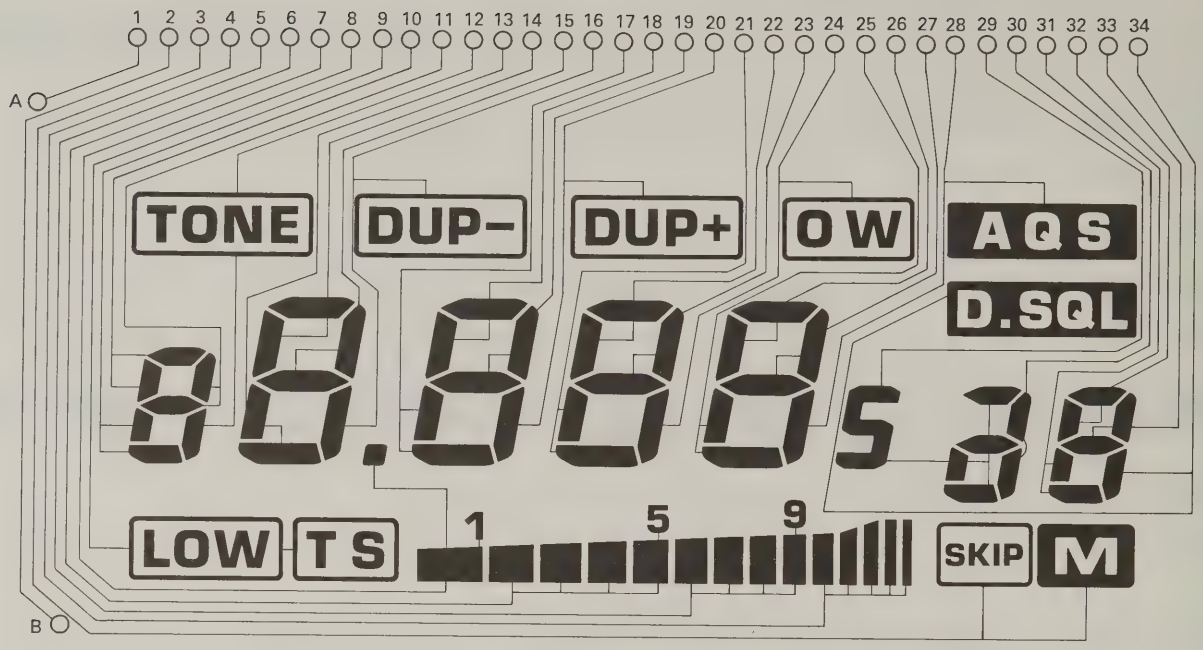
IC-28E/H
(EUROPE VERSIONS)

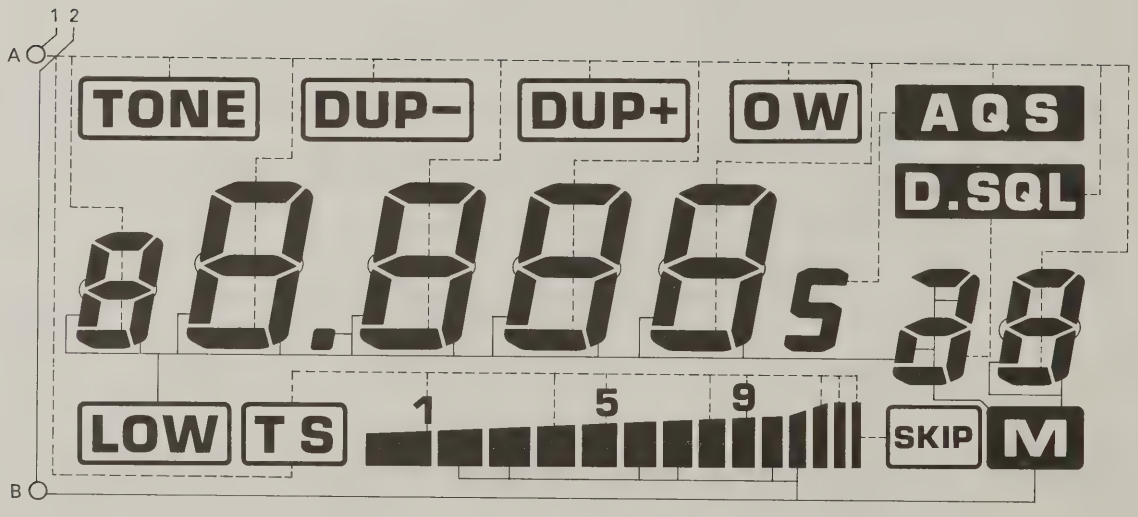


IC-28E/H
(SPAIN, ITALY VERSIONS)



■ LCD DISPLAY


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34
A
B
TONE
DUP–
DUP+
OW
AQS
D.SQL
LOW
TS
1
5
9
SKIP
M


1 2
A
B
TONE
DUP–
DUP+
OW
AQS
D.SQL
LOW
TS
1
5
9
SKIP
M

4 - 4 - 3 S-INDICATOR AND RF-INDICATOR

S/RF signals from ports P71 ~ P73 are fed to R14 ~ R17 which are used for digital/analog (D/A) conversion. The output voltage of the D/A converter is compared with a reference voltage of the S/RF at IC2, a comparator IC chip. If the reference voltage is higher than the voltage of the D/A converter, IC2 outputs "HIGH" level voltage. If the reference voltage is lower, IC2 outputs "LOW" level voltage. The output signal of IC2 is fed to port P60.

- Receiving

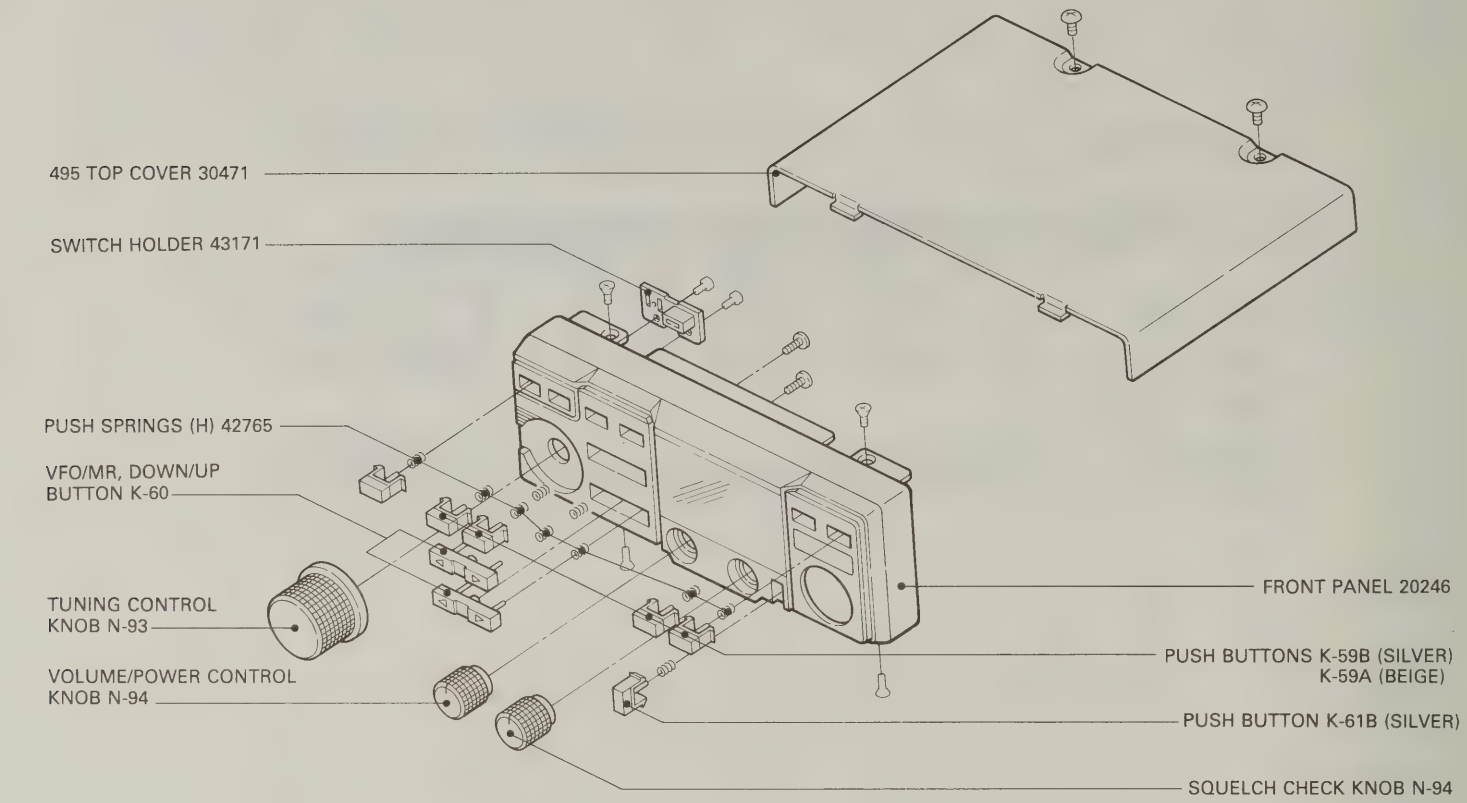
When the transceiver is in the receive mode, the S-INDICATOR appears as shown in the chart below.

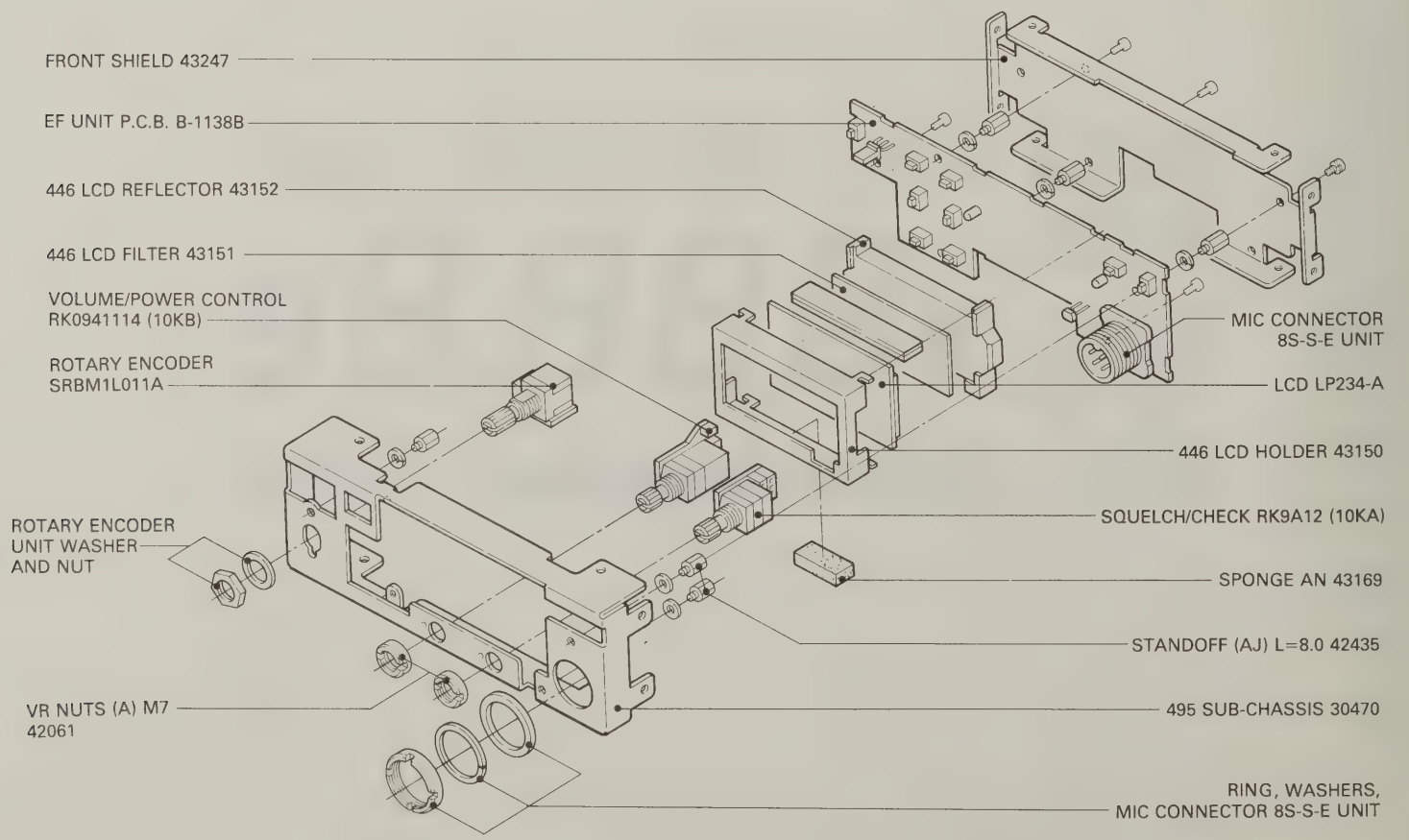
- Transmitting

When transmitting, P71 and P72 output "HIGH", P73 outputs "LOW", and P60 outputs "HIGH". If the high power output is selected, all ports from P71 ~ P73 are "HIGH" and the bar indicator appears at S-7. If low power output is selected, the bar indicator appears at S-3. When P60 is "LOW", the bar indicator does not appear on the LCD DISPLAY.

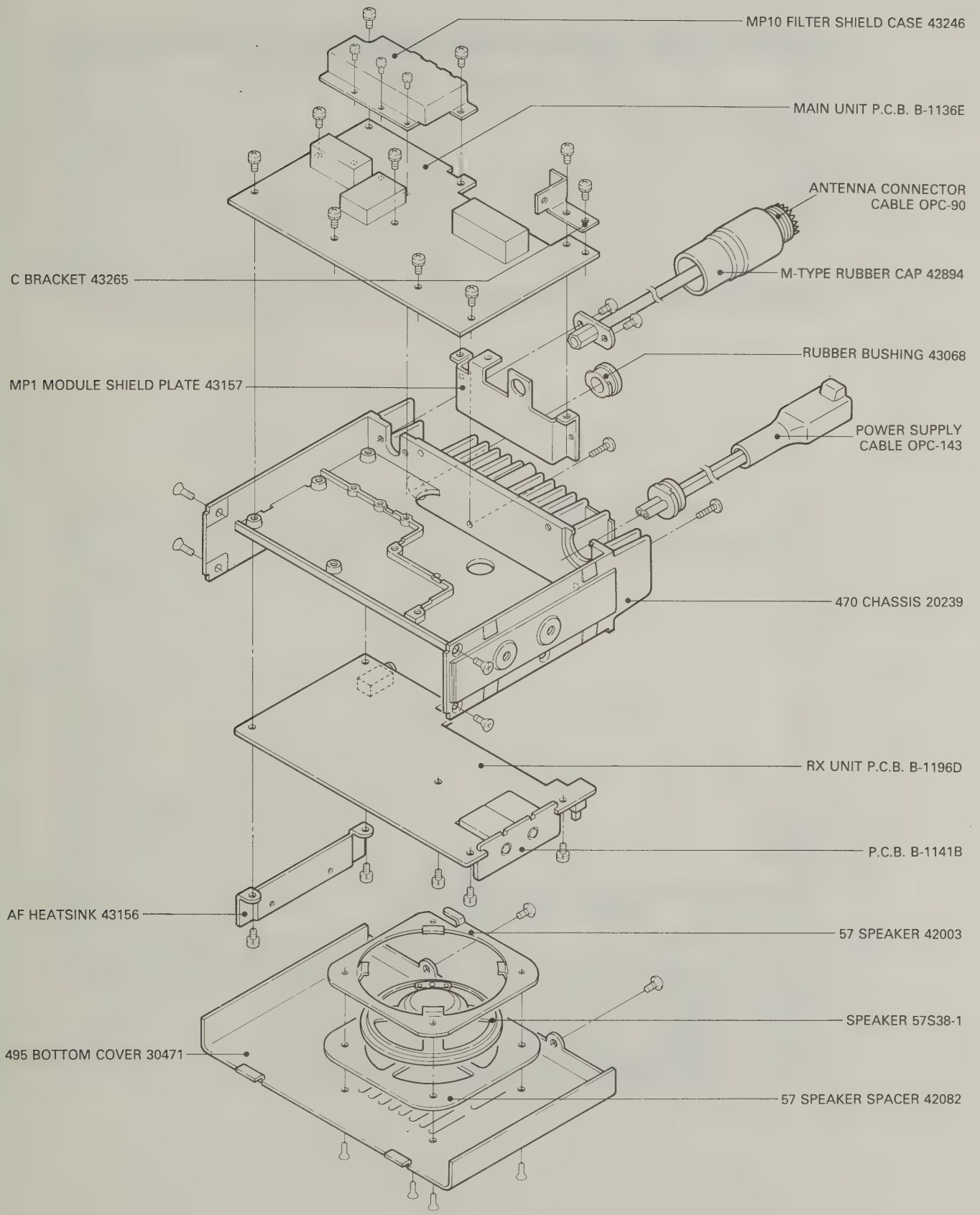
P73	P72	P71	NO. OF BARS
L	L	L	S-0
L	L	H	S-1
L	H	L	S-3
L	H	H	S-5
H	L	L	S-7
H	L	H	S-9
H	H	L	S-11
H	H	H	S-14

5 - 1 FRONT PANEL DISASSEMBLY

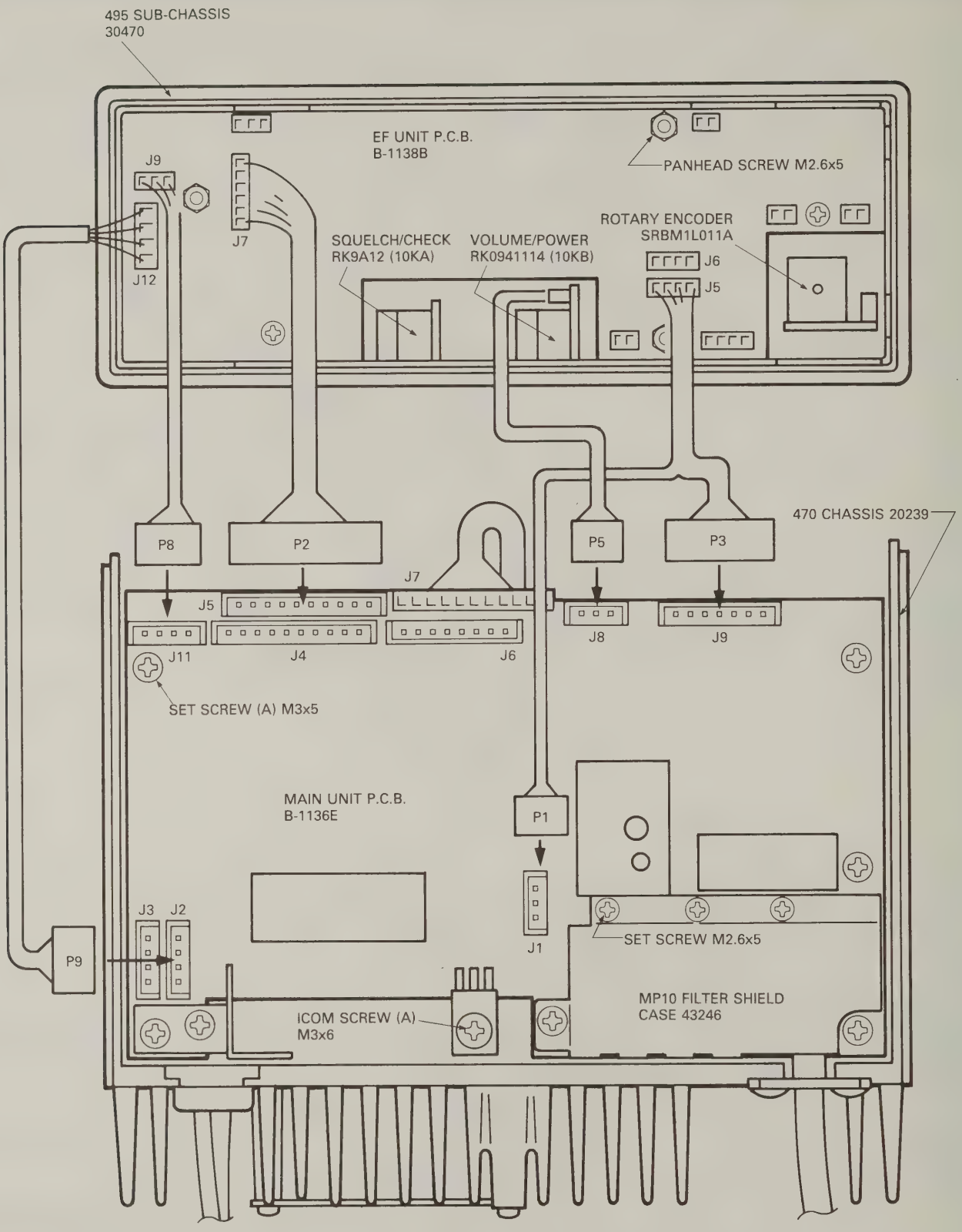




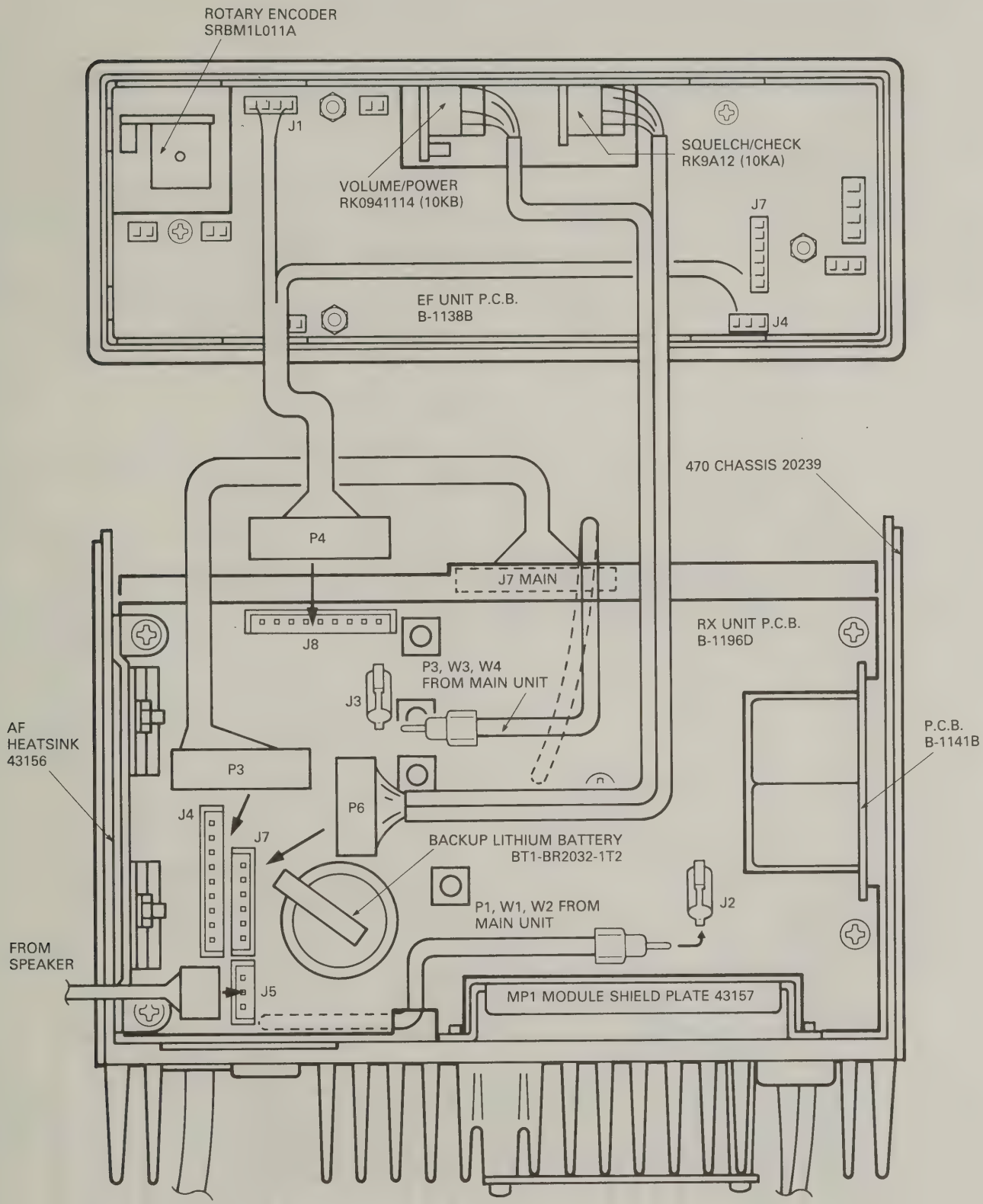
5 - 2 FRAME DISASSEMBLY



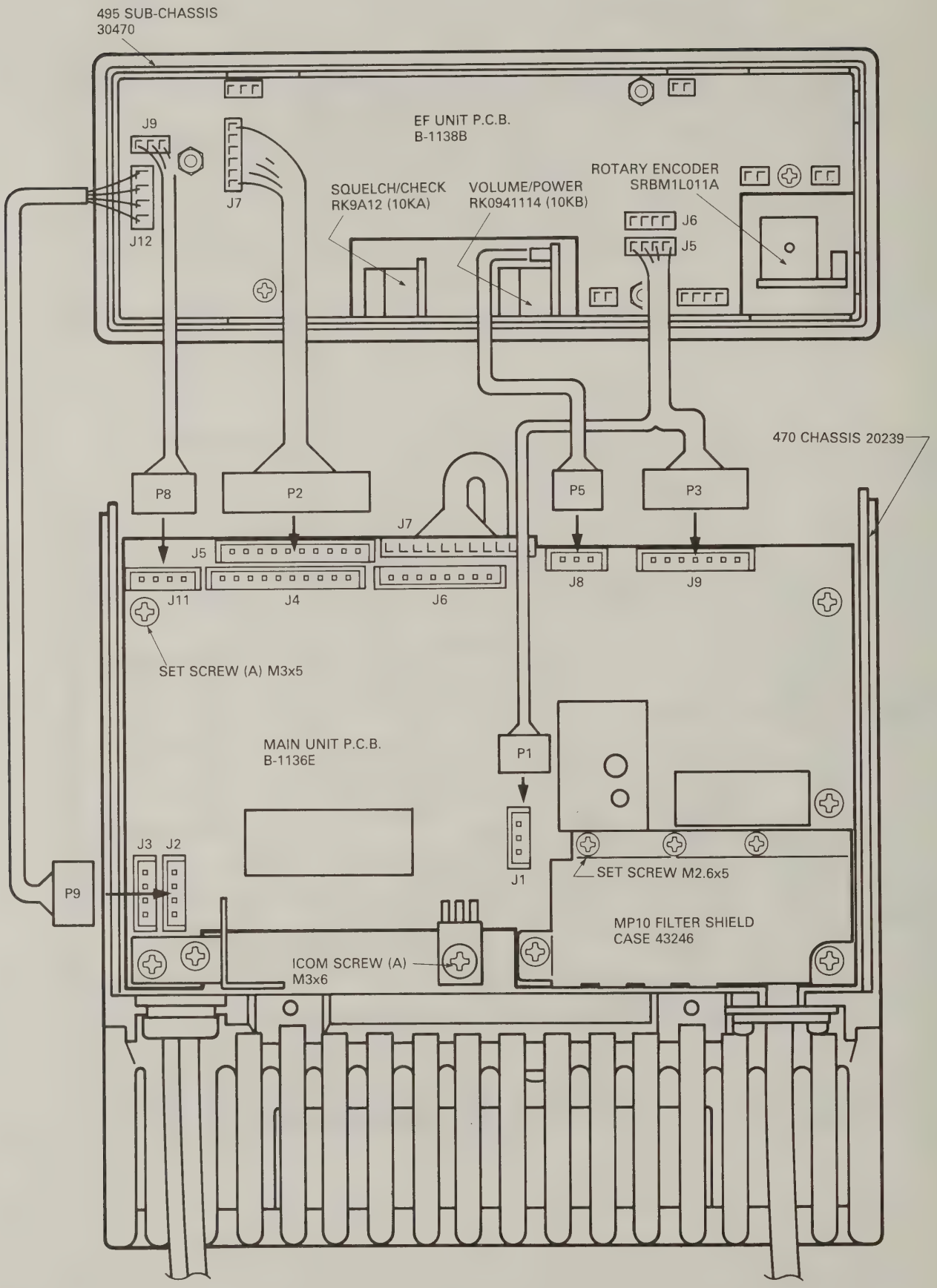
5 - 3 MAIN UNIT CONNECTOR ASSEMBLY (IC-28A/E VERSIONS)



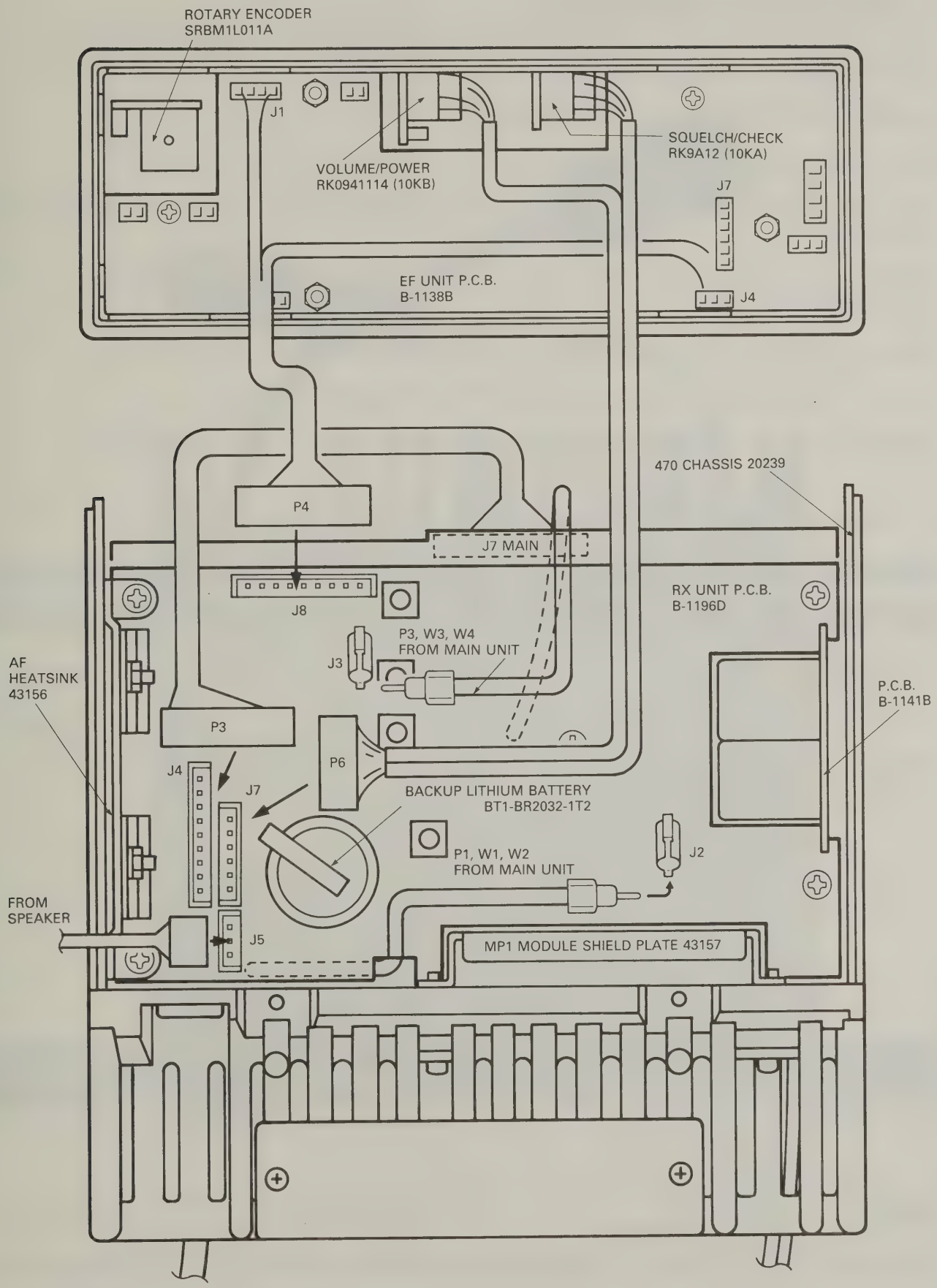
5 - 4 RX UNIT CONNECTOR ASSEMBLY (IC-28A/E VERSIONS)



5 - 5 MAIN UNIT CONNECTOR ASSEMBLY (IC-28H VERSIONS)



5 - 6 RX UNIT CONNECTOR ASSEMBLY (IC-28H VERSIONS)



SECTION 6 MAINTENANCE AND ADJUSTMENT

6 - 1 PREPARATION BEFORE SERVICING

1. Detach the power cord and turn OFF the VOLUME CONTROL/POWER SWITCH before performing any work on the transceiver.

2. Do not short circuit components while making adjustments.

3. Use an insulated tuning tool for all adjustments. Be sure to use the correct tools and test equipment.

4. Follow the instructions exactly. If an indicated result is not obtained, repeat the instruction until the correct result is obtained.

5. Check the condition of connectors, solder joints and screws when adjustments are complete. Confirm that components do not touch each other.

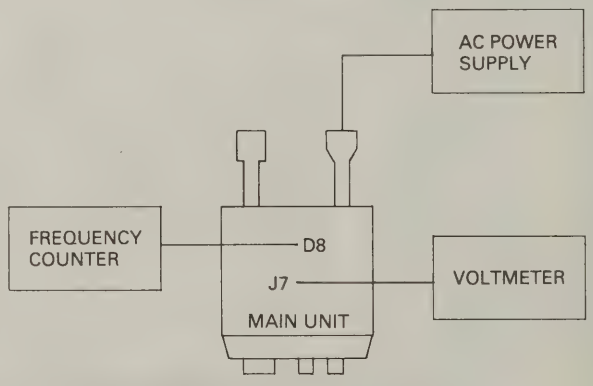
6. Attach a 13.8 volt DC external power source to the power supply connector. Be sure to check the polarity.

7. Recheck for the suspected malfunction with the VOLUME CONTROL/POWER SWITCH ON.

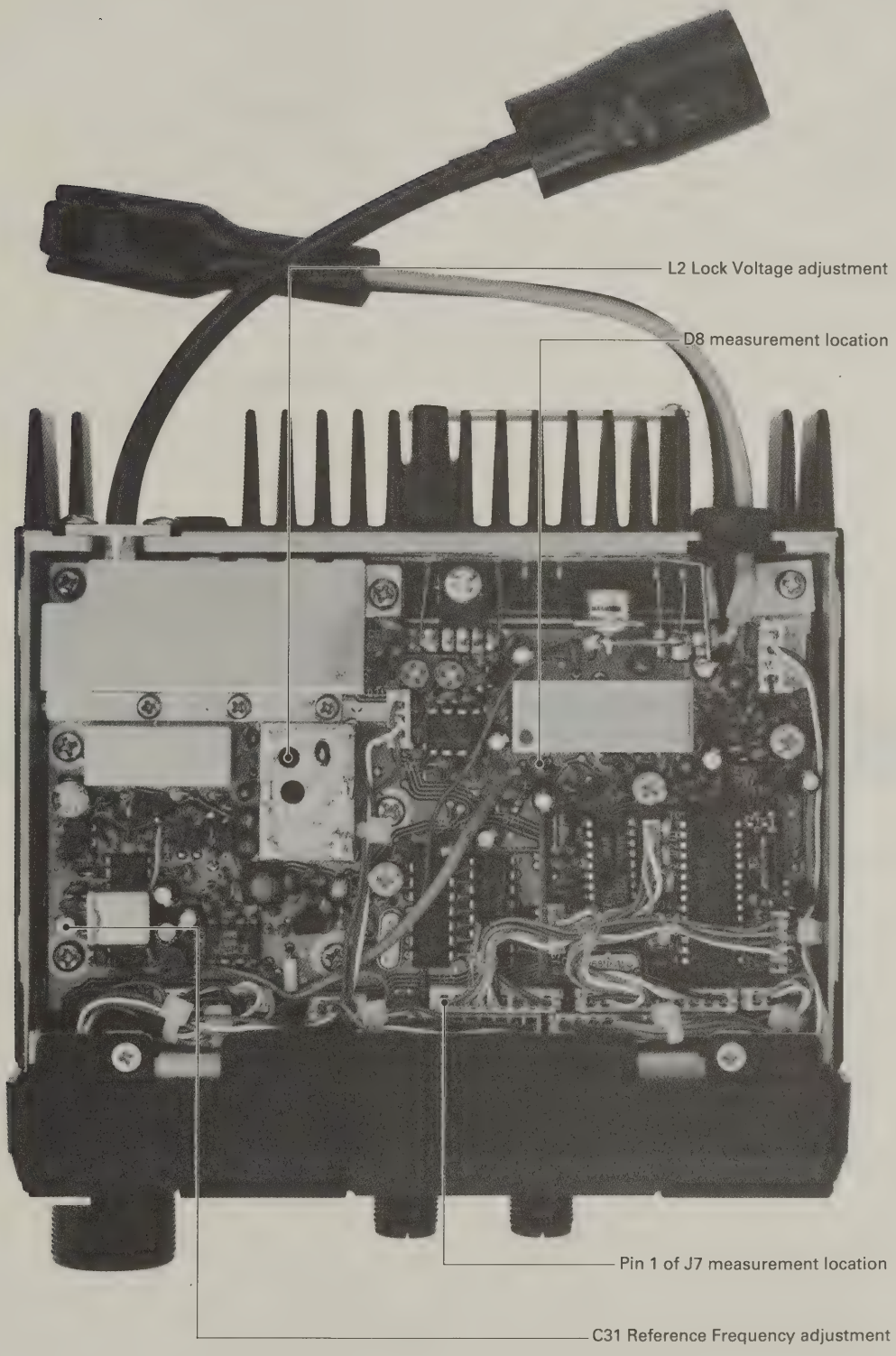
8. Check the defective circuit. Measure the DC voltages of the collector, base and emitter of each transistor.

6 - 2 PLL ADJUSTMENT

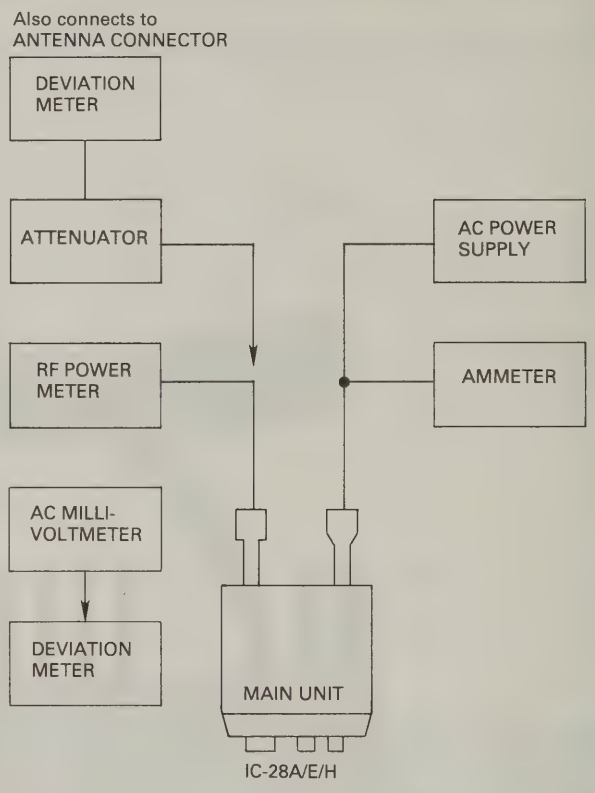
NOTE: Adjustment requirements are generally the same for each IC-28A/E/H version. Variations are noted in brackets.

TEST INSTRUMENTS REQUIRED	MEASUREMENT CONNECTION LOCATION
(1) VOLTAGE REGULATED POWER SUPPLY • Output voltage : 13.8V DC ±15% • Current capacity : 10A or more (2) VOLTMETER • Input impedance : 50kΩ/V DC or better (3) FREQUENCY COUNTER • Frequency minimum : 0.1 ~ 470MHz • Frequency accuracy : 1ppm or better • Sensitivity : 100mV or better	 IC-28A/E/H

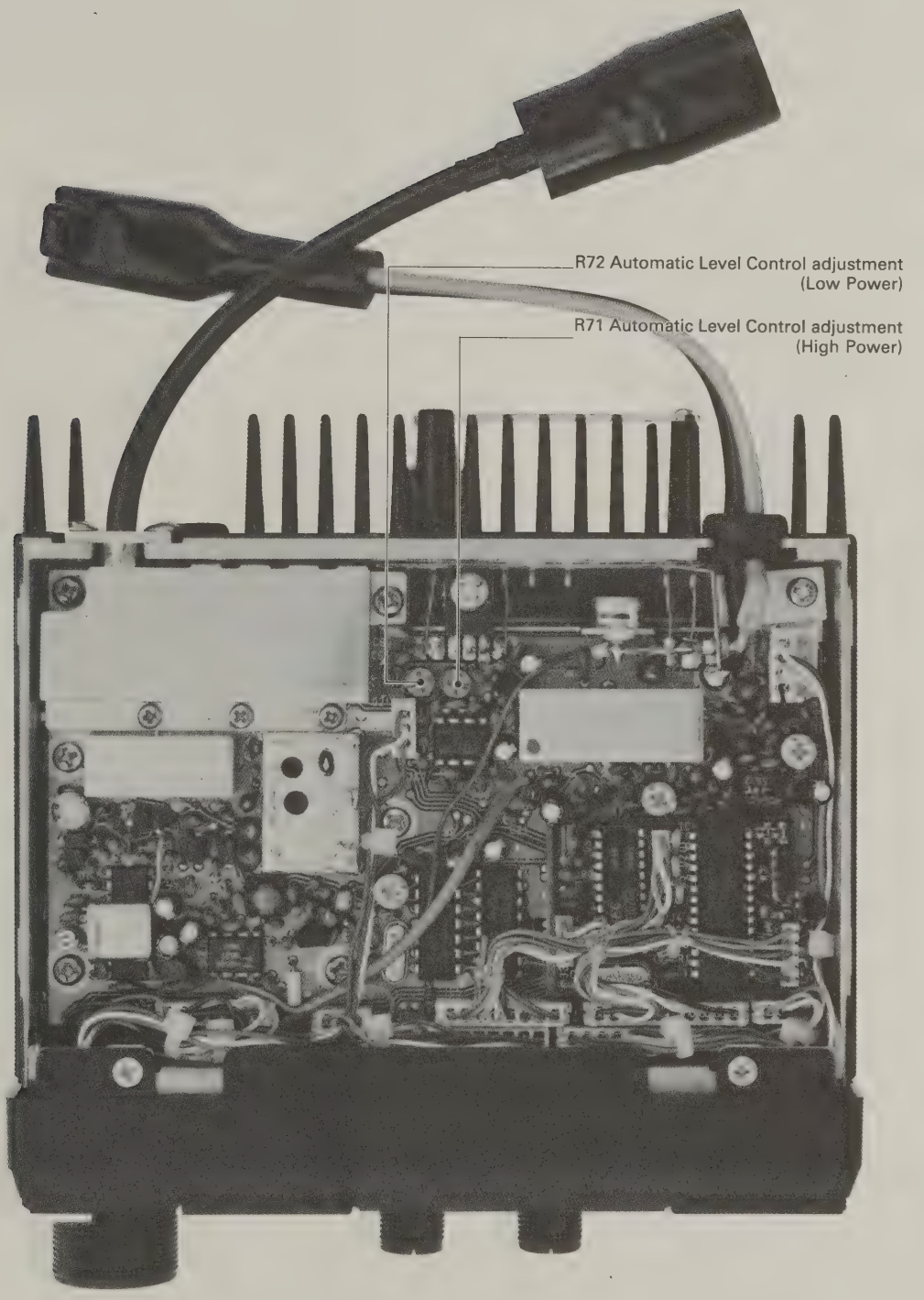
ADJUSTMENT		ADJUSTMENT CONDITIONS	MEASUREMENT		VALUE	ADJUSTMENT POINT	
			UNIT	LOCATION		UNIT	ADJUST
LOCK VOLTAGE	1	• Frequency display: 146.010MHz (#01) 145.000MHz (#03, #04, #05) • Receive mode	MAIN	Connect a voltmeter to pin 1 of J7.	6.0V (#01) 5.5V (#03, #04, #05)	MAIN	L2
REFERENCE FREQUENCY	1	• Display frequency: 146.010MHz (#01) 145.000MHz (#03, #04, #05) • Receive mode	MAIN	Connect a frequency counter to the cathode of D8.	128.810MHz (#01) 127.800MHz (#03, #04, #05)	MAIN	C31


L2 Lock Voltage adjustment
D8 measurement location
Pin 1 of J7 measurement location
C31 Reference Frequency adjustment

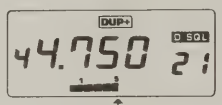
6 - 3 TRANSMITTER ADJUSTMENT

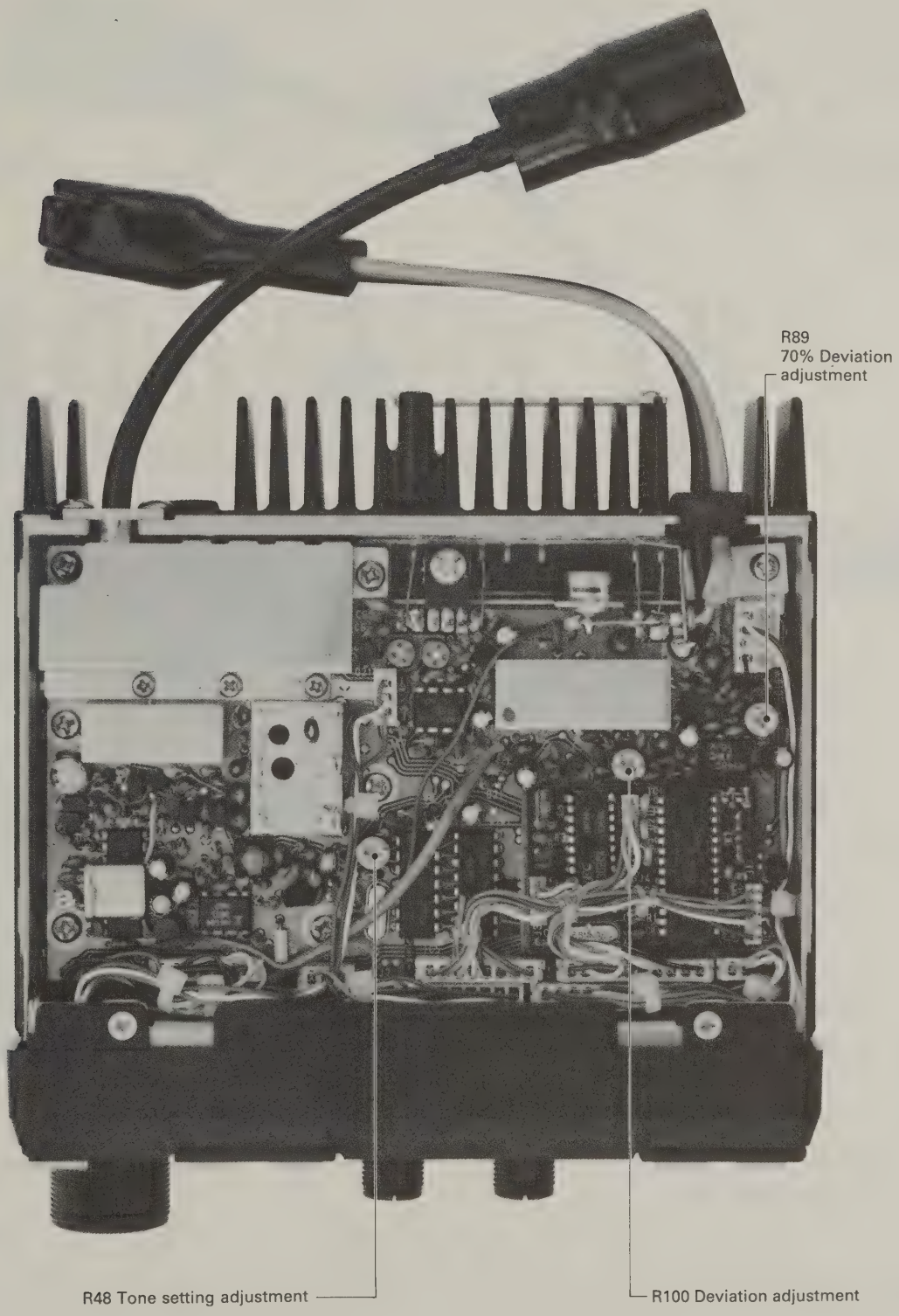
TEST INSTRUMENTS REQUIRED	MEASUREMENT CONNECTION LOCATION
(1) VOLTAGE REGULATED POWER SUPPLY • Output voltage : 13.8V DC ±15% • Current capacity : 10A or more (2) RF POWER METER • Terminated type • Minimum power rating : 150W • Frequency minimum : 30MHz • Input impedance : 50Ω • SWR : 1:1.2 or better (3) AMMETER • Input impedance : 50kΩ/V DC or better • Measurement minimum : 100mA and 600mA (4) DEVIATION METER • Frequency minimum : 30MHz • Measuring range : 0 ~ ±5kHz • De-emphasis : OFF (5) AC MILLI-VOLTMETER • Measuring range : 5mV ~ 1V (6) ATTENUATOR	

ADJUSTMENT		ADJUSTMENT CONDITIONS	MEASUREMENT		VALUE	ADJUSTMENT POINT	
			UNIT	LOCATION		UNIT	ADJUST
ALC (Automatic Level Control) ⓐ HIGH POWER	1	• Frequency display: 146.010MHz (#01) 145.000MHz (#03, #04, #05) • HIGH/LOW POWER: HIGH • Transmit mode	REAR PANEL	Connect an RF power meter to the ANTENNA CONNECTOR.	27W 47W (IC-28H version)	MAIN	R71
ⓑ LOW POWER	2	• HIGH/LOW POWER: LOW			5W	MAIN	R72
VERIFY OUTPUT POWER AT BAND EDGES	1	• Frequency display: 144.000, 147.995 (#01) 144.000, 145.975 (#03, #04, #05) • HIGH/LOW POWER: HIGH • Transmit mode	REAR PANEL	Connect an RF power meter to the ANTENNA CONNECTOR.	More than 25W More than 45W (IC-28H version)		Verify
	2	• HIGH/LOW POWER: LOW			4 ~ 6W		Verify

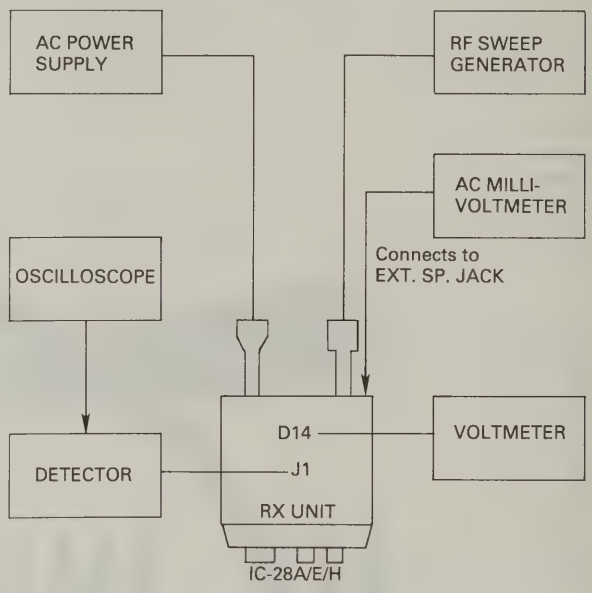

R72 Automatic Level Control adjustment
(Low Power)
R71 Automatic Level Control adjustment
(High Power)

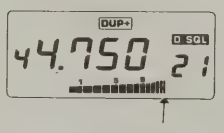
TRANSMITTER ADJUSTMENT

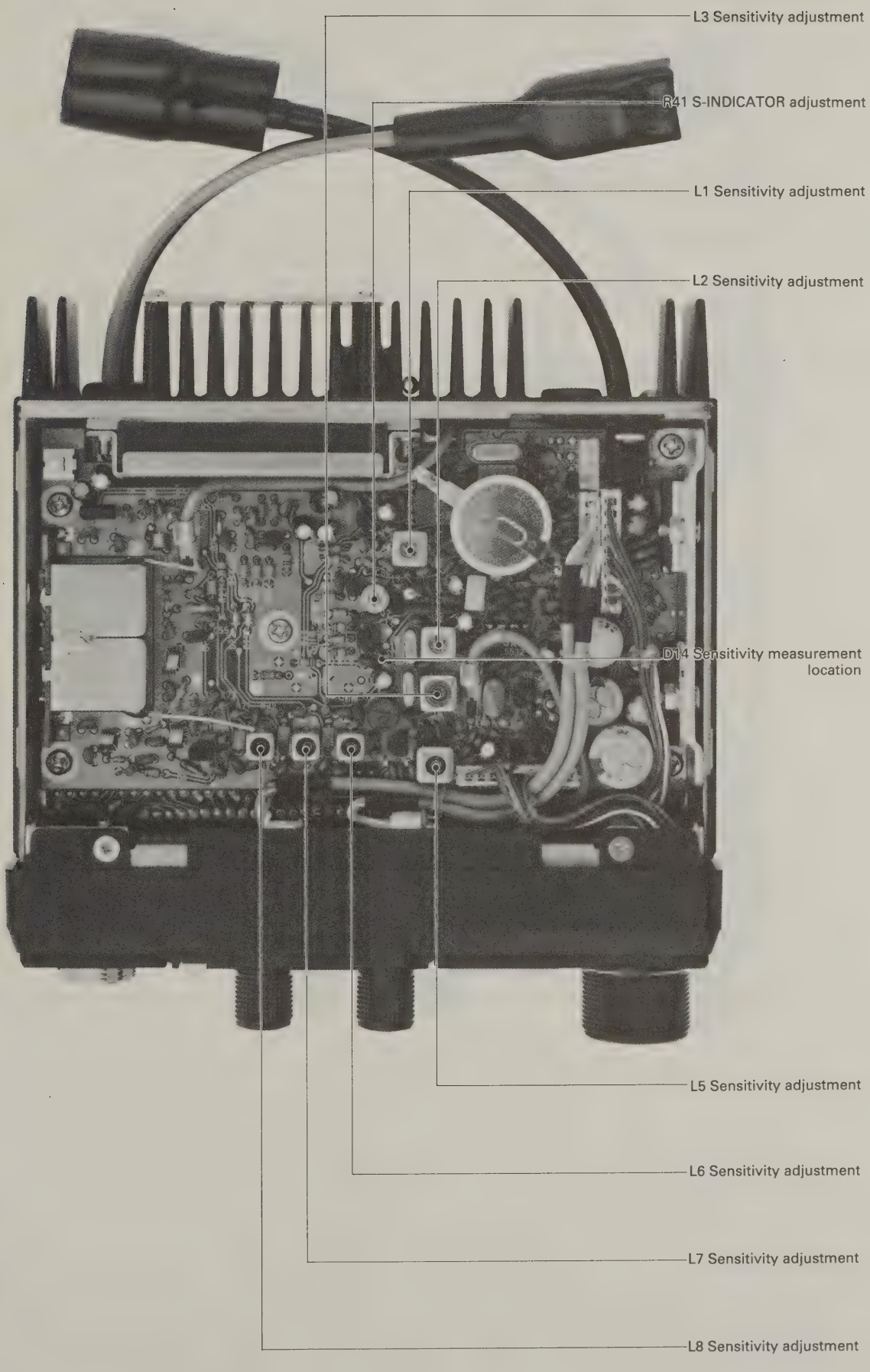
ADJUSTMENT		ADJUSTMENT CONDITIONS	MEASUREMENT		VALUE	ADJUSTMENT POINT	
			UNIT	LOCATION		UNIT	ADJUST
RF LEVEL INDICATOR	1	• Frequency display: 146.010 (#01) 145.000 (#03, #04, #05) • HIGH/LOW POWER: HIGH • Transmit mode	DISPLAY	 RF LEVEL INDICATOR is at full scale.	Full scale		Verify
	2	• HIGH/LOW POWER: LOW		 RF LEVEL INDICATOR is at S5.	S5		Verify
TRANSMIT CURRENT	1	• Frequency display: 146.010MHz (#01) 145.000MHz (#03, #04, #05) • HIGH/LOW POWER: HIGH • Transmit mode	REAR PANEL	Connect an Ammeter between the Power supply and the transceiver.	Less than 5.8A Less than 9.5A (IC-28H version)		Verify
	2	• HIGH/LOW POWER: LOW			Less than 3.0A Less than 3.5A (IC-28H version)		Verify
DEVIATION ⓐ MAXIMUM	1	• Frequency display: 146.010MHz (#01) 145.000MHz (#03, #04, #05) • HIGH/LOW POWER: HIGH • Transmit mode	REAR PANEL	Connect a Deviation meter to the ANTENNA CONNECTOR through an attenuator.	±4.8kHz	MAIN	R100
		• Apply a 1kHz 65mV AF signal to the MIC CONNECTOR (#01) • Apply a 1kHz 20mV AF signal to the MIC CONNECTOR (#03, #04, #05)					
ⓑ 70%	2	• Apply 1kHz 6.5mV (20dB down) to the MIC CONNECTOR (#01) • Apply 1kHz 2.0mV (20dB down) to the MIC CONNECTOR (#03, #04, #05)					
TONE SETTING (#01 only)	1	• Frequency display: 146.010MHz • Tone number: 38 • Apply no signal to the MIC CONNECTOR • Transmit mode	REAR PANEL	Connect a Deviation meter to the ANTENNA CONNECTOR through an attenuator.	±0.75kHz	MAIN	R48
	2	• Tone number: 01			±0.5 ~ ±1kHz		Verify
S/N RATIO	1	• Frequency display: 146.010MHz (#01) 145.000MHz (#03, #04, #05) • Apply a 1kHz 6.5mV AF signal to the MIC CONNECTOR (#01) • Apply a 1kHz 2.0mV AF signal to the MIC CONNECTOR (#03, #04, #05) • Transmit mode	REAR PANEL	Connect an AC Milli-voltmeter to the Deviation meter.	Record the reading.		
	2	• Apply no signal to the MIC CONNECTOR			Record the reading.		
		NOTE: Verify that the recorded ratio is greater than 40dB (See steps 1 and 2).					


R89
70% Deviation
adjustment
R48 Tone setting adjustment
R100 Deviation adjustment

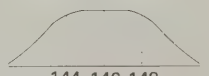
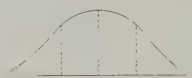
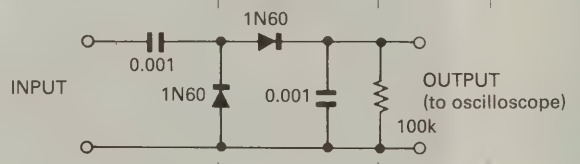
6 - 4 RECEIVER ADJUSTMENT

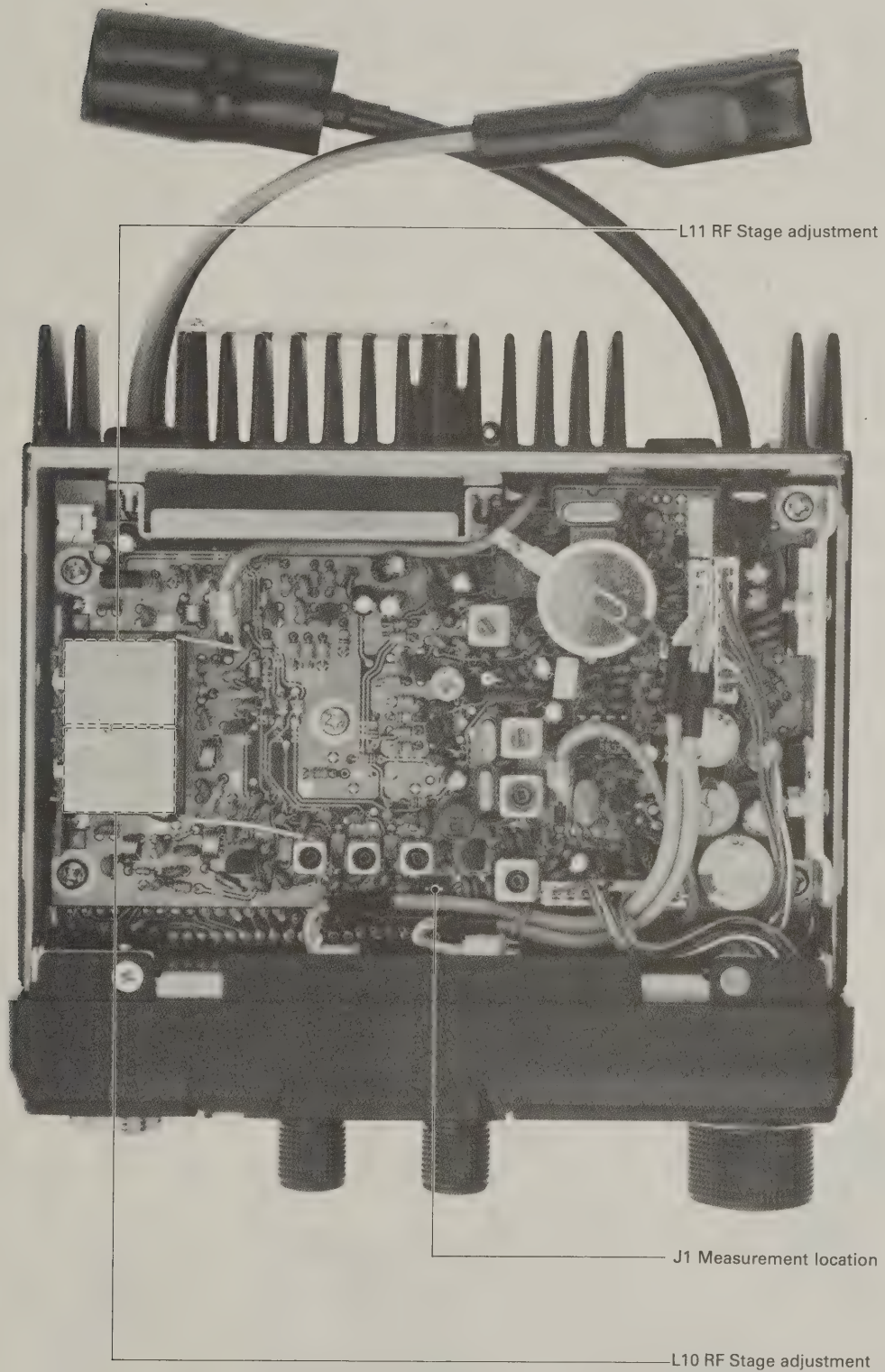
TEST INSTRUMENTS REQUIRED	MEASUREMENT CONNECTION LOCATION
(1) VOLTAGE REGULATED POWER SUPPLY • Output voltage : 13.8V DC ±15% • Current capacity : 10A or more (2) VOLTMETER • Input impedance : 50kΩ/V DC or better (3) AC MILLI-VOLTMETER • Measuring range : 5mV ~ 1V (4) OSCILLOSCOPE • Frequency range : DC ~ 20MHz • Measuring range : 0.01 ~ 10V (5) RF SWEEP GENERATOR • Center frequency : 140MHz ~ 150MHz • Sweep bandwidth : ±10MHz • Output impedance : 50Ω (6) DETECTOR	

ADJUSTMENT		ADJUSTMENT CONDITIONS	MEASUREMENT		VALUE	ADJUSTMENT POINT	
			UNIT	LOCATION		UNIT	ADJUST
SENSITIVITY	1	• Frequency display: 146.010MHz (#01) 145.000MHz (#03, #04, #05) • Turn R41 completely CW • Apply RF signal to the ANTENNA CONNECTOR Level : 1µV (−107dBm) Deviation : ±3.5kHz Modulation : 1kHz	RX	Connect a voltmeter to the cathode of D14.	Maximum value	RX	L7, L6 L5, L3 L2, L1
		NOTE: Verify that the sensitivity in all bands is below 0.18µV (−122dBm) for 12dB SINAD.					
S-INDICATOR	1	• Frequency display: 146.010MHz (#01) 145.000MHz (#03, #04, #05) • Apply RF signal to the ANTENNA CONNECTOR Level : 1µV (−107dBm) Deviation : ±3.5kHz Modulation : 1kHz	DISPLAY	 S-INDICATOR is at S3.	S3	RX	R41
	2	• Apply RF signal to the ANTENNA CONNECTOR Level : 5.0µV (−93dBm) Deviation : ±3.5kHz Modulation : 1kHz		 S-INDICATOR is at full scale.	Full scale		Verify

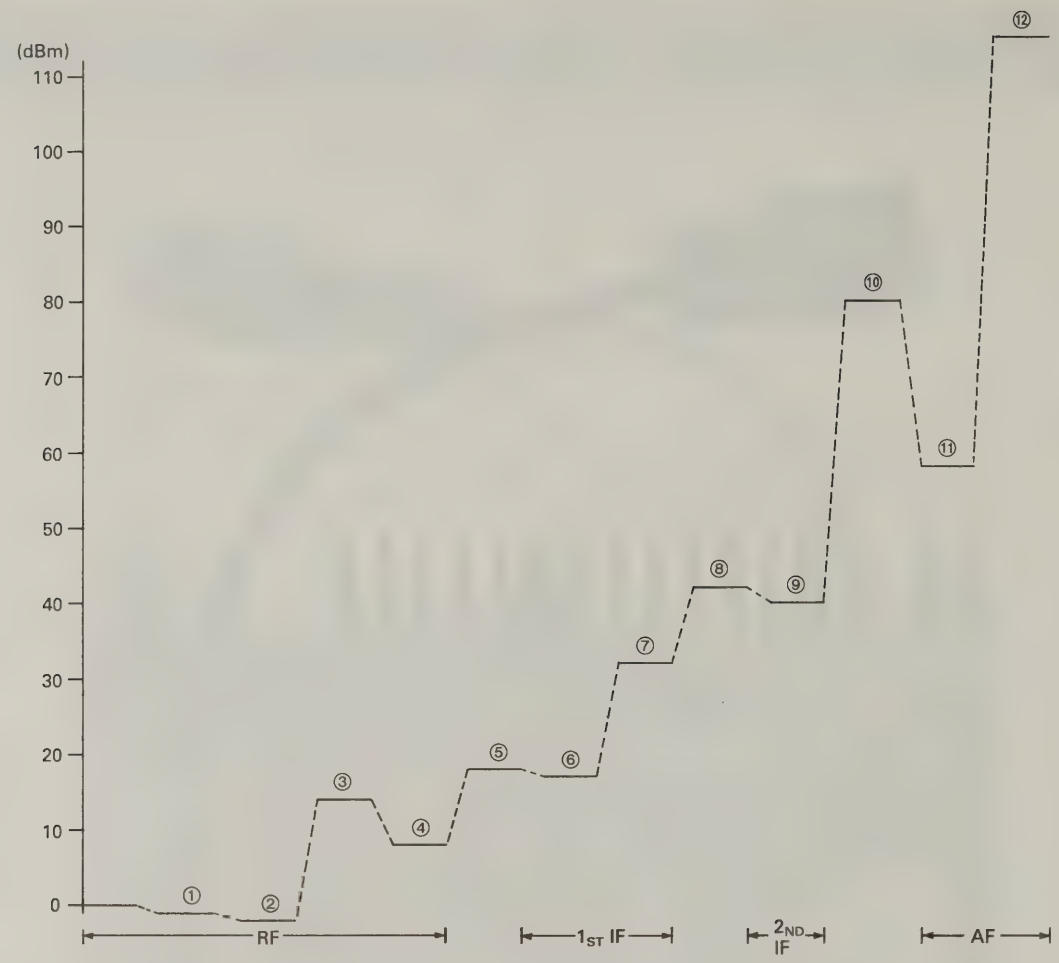

L3 Sensitivity adjustment
R41 S-INDICATOR adjustment
L1 Sensitivity adjustment
L2 Sensitivity adjustment
D14 Sensitivity measurement location
L5 Sensitivity adjustment
L6 Sensitivity adjustment
L7 Sensitivity adjustment
L8 Sensitivity adjustment

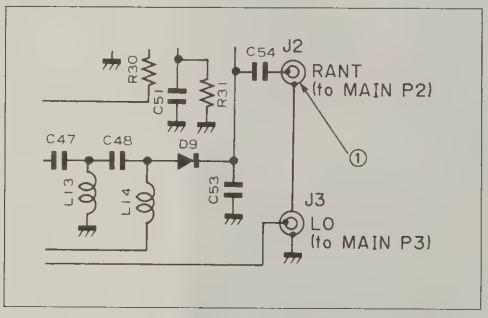
RECEIVER ADJUSTMENT

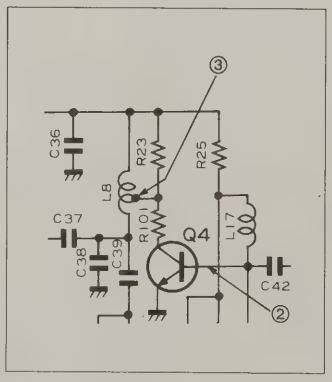
ADJUSTMENT		ADJUSTMENT CONDITIONS	MEASUREMENT		VALUE	ADJUSTMENT POINT	
			UNIT	LOCATION		UNIT	ADJUST
SQUELCH	1	• Apply RF signal to ANTENNA CONNECTOR Level : 0.11μV (−126dBm) Deviation : ±3.5kHz Modulation : 1kHz • Adjust SQUELCH CONTROL to threshold point			SQUELCH opens		Verify
	2	• Apply RF signal to the ANTENNA CONNECTOR Level : 0.5μV (−113dBm) Deviation : ±3.5kHz Modulation : 1kHz • Turn SQUELCH CONTROL to maximum CW			SQUELCH opens		Verify
AF OUTPUT POWER	1	• Apply RF signal to the ANTENNA CONNECTOR Level : 10μV (−87dBm) Deviation : ±3.5kHz Modulation : 1kHz • Turn AF VOLUME CONTROL to maximum CW	REAR PANEL	Connect an AC milli-voltmeter to the transceiver EXTERNAL SPEAKER JACK using an 8Ω load.	More than 4.4V at 10% distortion.		Verify
RF STAGE		**NOTE:** The Bandpass Filter unit in the RF stage has been thoroughly adjusted prior to leaving the factory. The following should be regarded as reference material.					
	1	• Unplug P2 from J3 • Apply an RF sweep generator to the ANTENNA CONNECTOR • Frequency range: 140MHz ~ 150MHz	RX	Connect an oscilloscope to J1 through the detector. (#01)  Unit: MHz (#03, #04, #05)  Unit: MHz Detector Circuit characteristics:  		BPF	L10, L11
						RX	L8, L7, L6 (See P. 6-8)

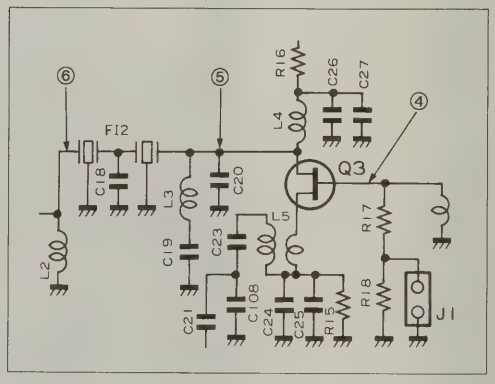

L11 RF Stage adjustment
J1 Measurement location
L10 RF Stage adjustment

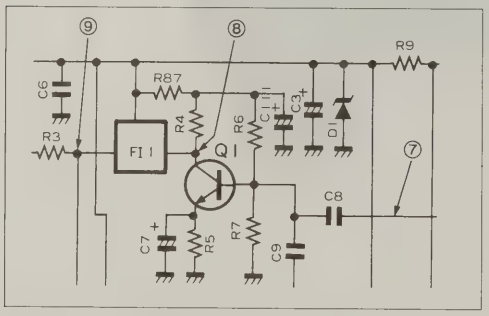
6 - 5 RX LEVEL DIAGRAM

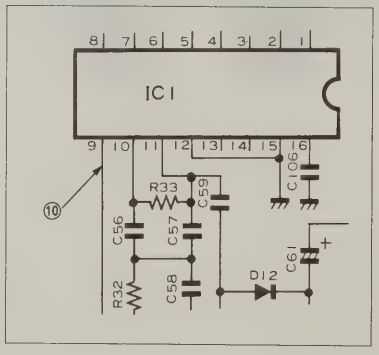


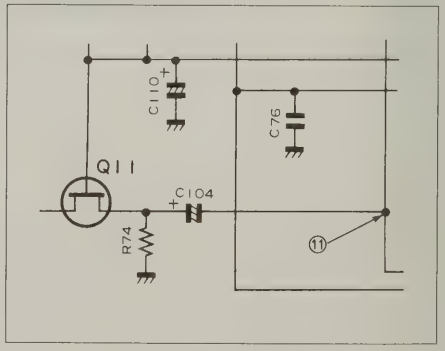


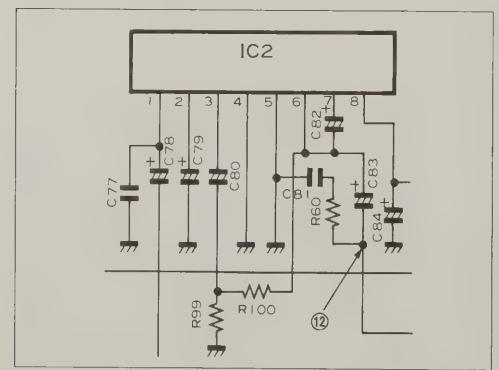








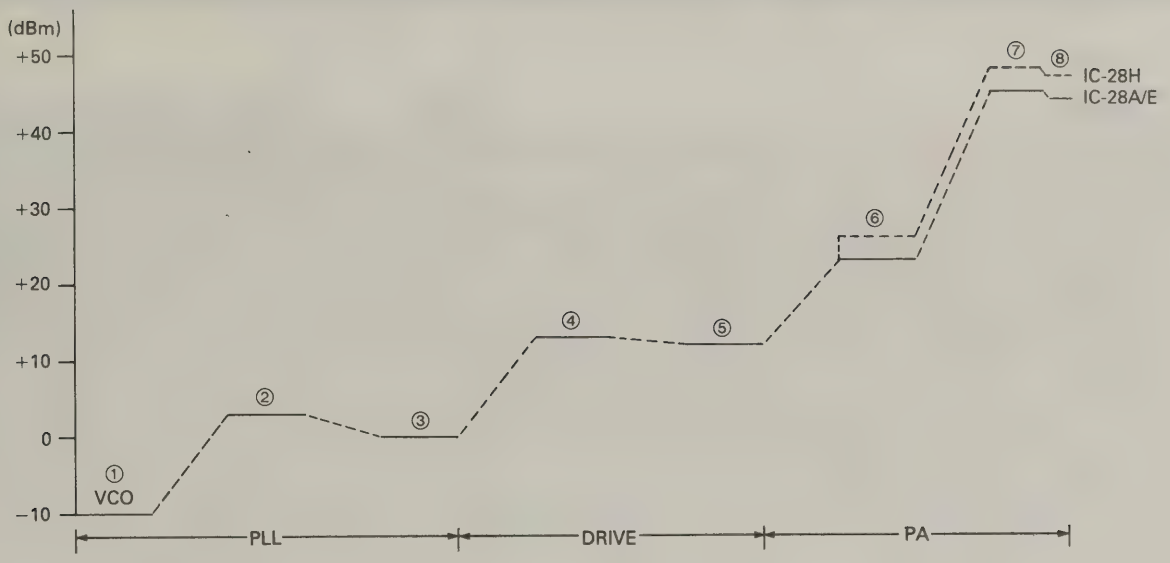


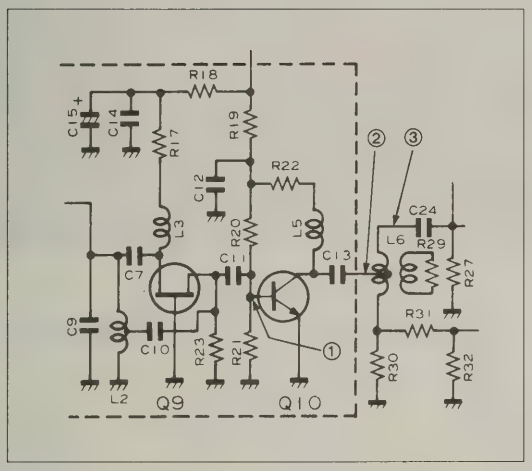


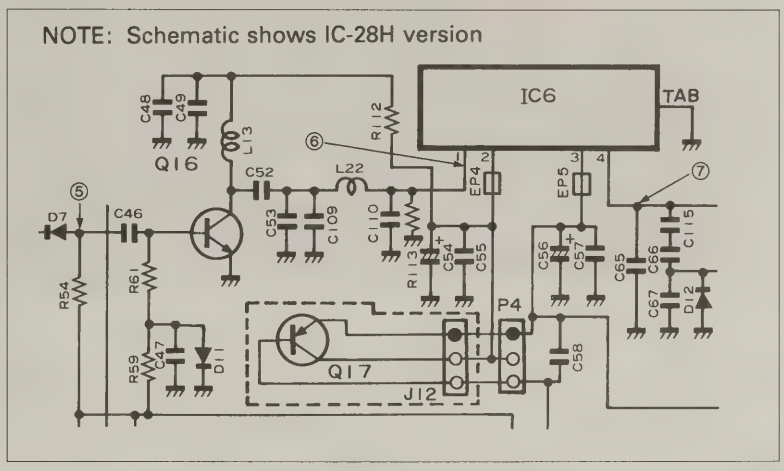
NOTE 1: For an accurate measure of the above levels, ensure that the impedance of your test equipment matches the impedance of the various test points.

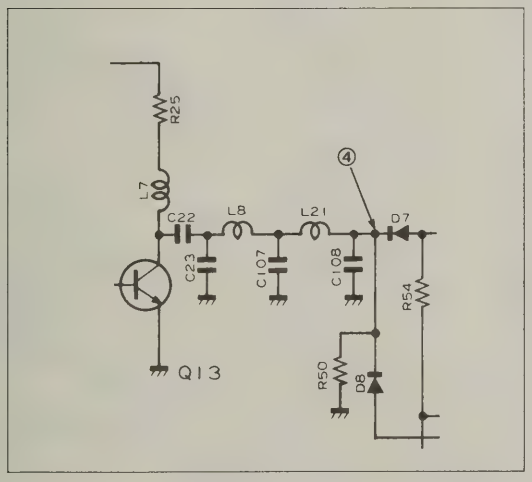
NOTE 2: The above levels are approximate to within ±6 dB.

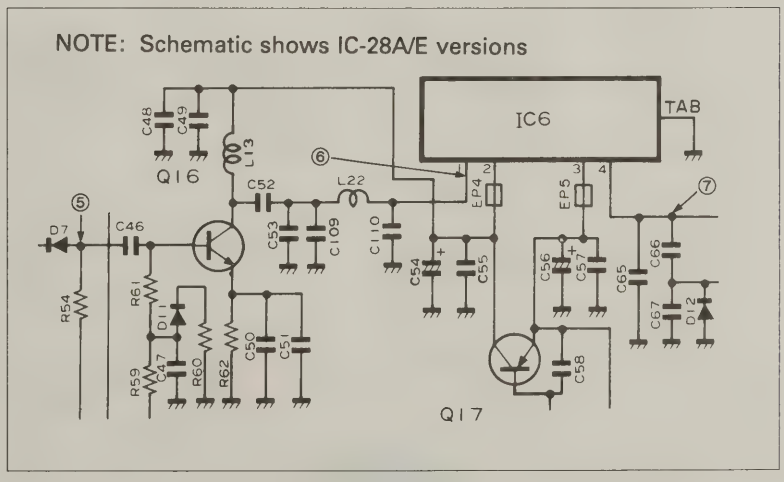
6 - 6 TX LEVEL DIAGRAM

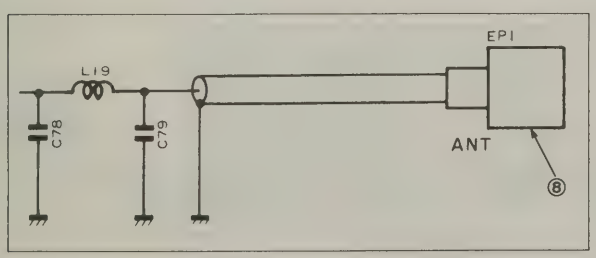








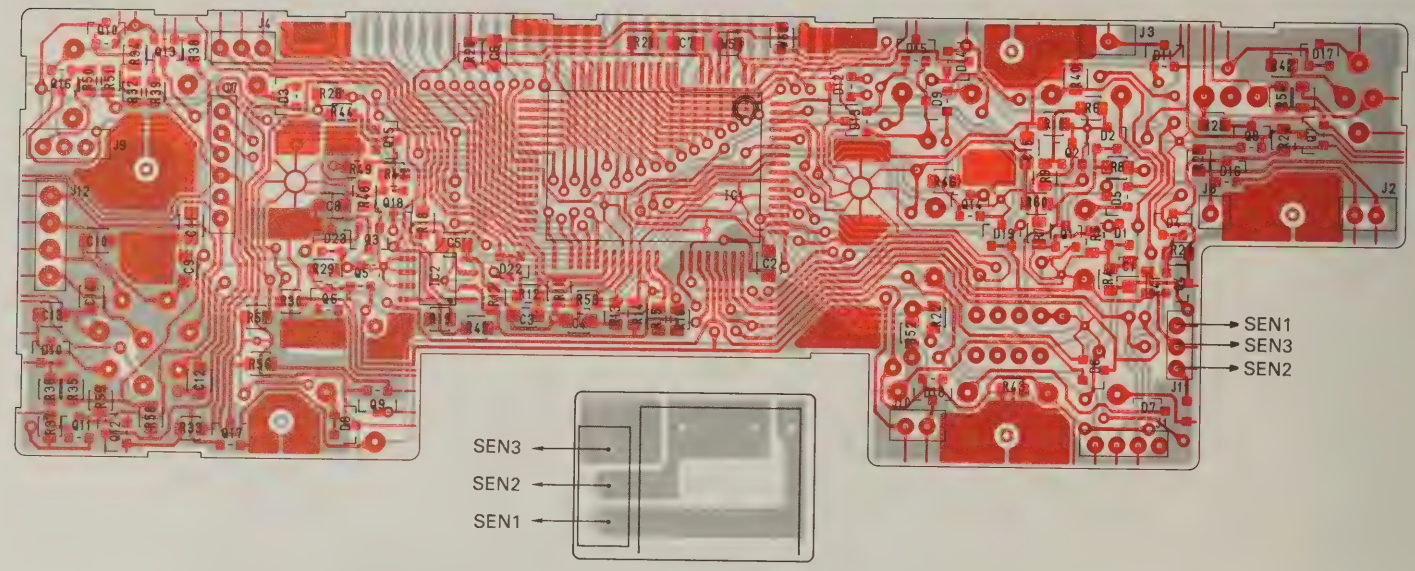




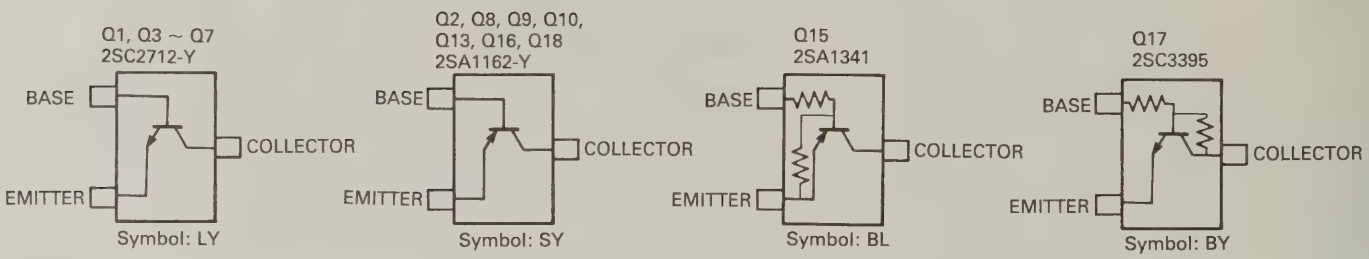
NOTE 1: For an accurate measure of the above levels, ensure that the impedance of your test equipment matches the impedance of the various test points.

NOTE 2: The above levels are approximate to within ±3 dB.

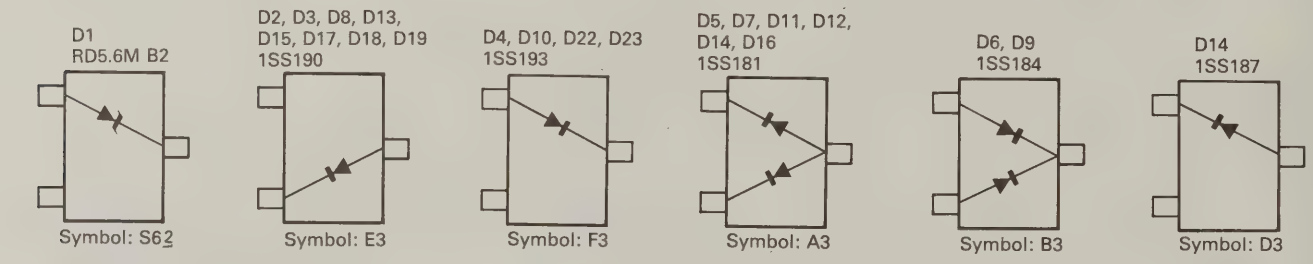
7 - 1 EF UNIT

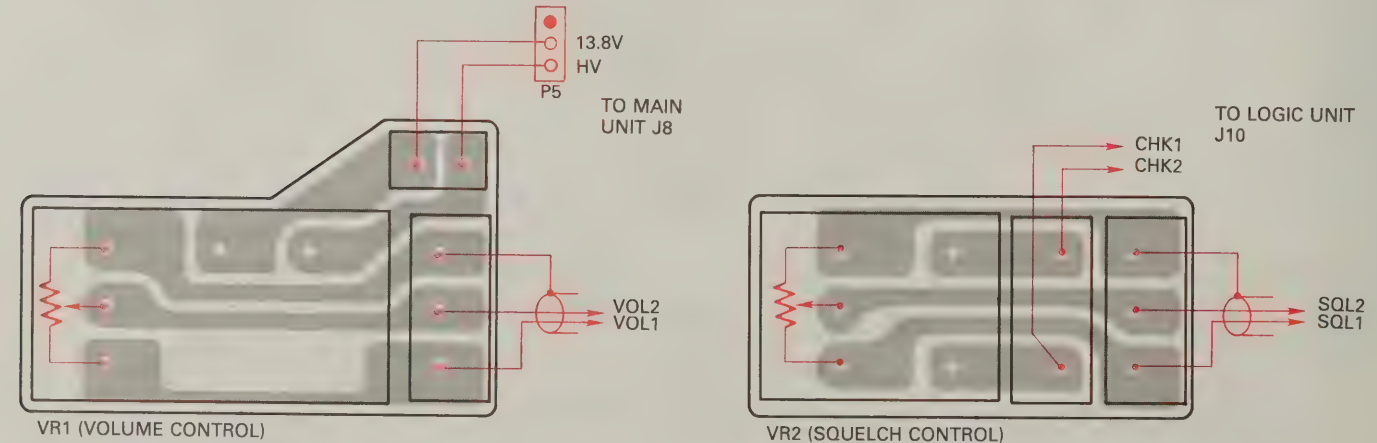


■ TRANSISTORS

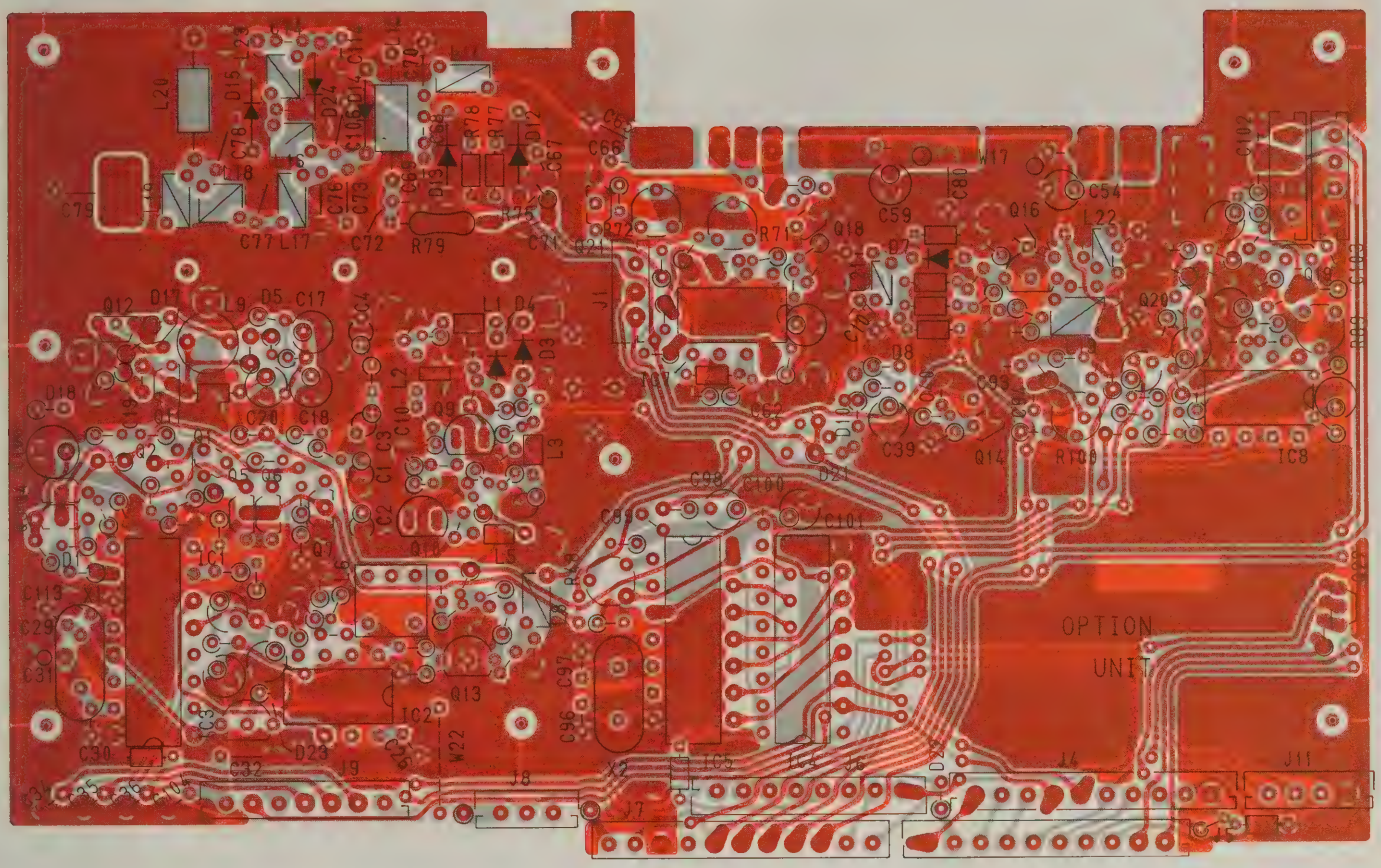


■ DIODES

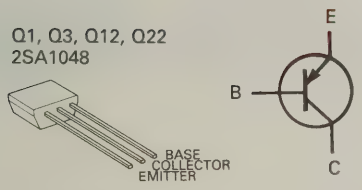




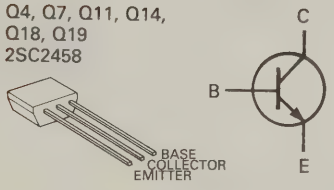
7 - 2 MAIN UNIT (IC-28A/E VERSIONS)



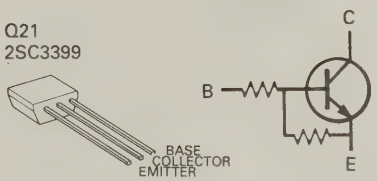
Q1, Q3, Q12, Q22
2SA1048



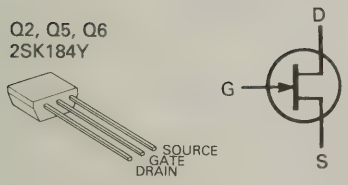
Q4, Q7, Q11, Q14,
Q18, Q19
2SC2458



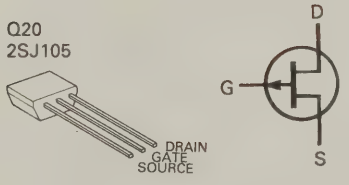
Q21
2SC3399



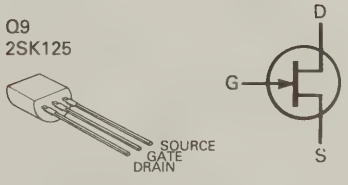
Q2, Q5, Q6
2SK184Y



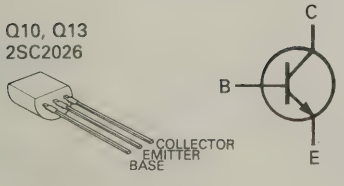
Q20
2SJ105



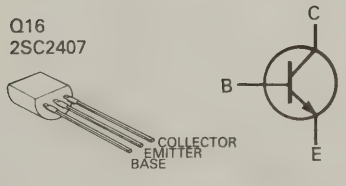
Q9
2SK125



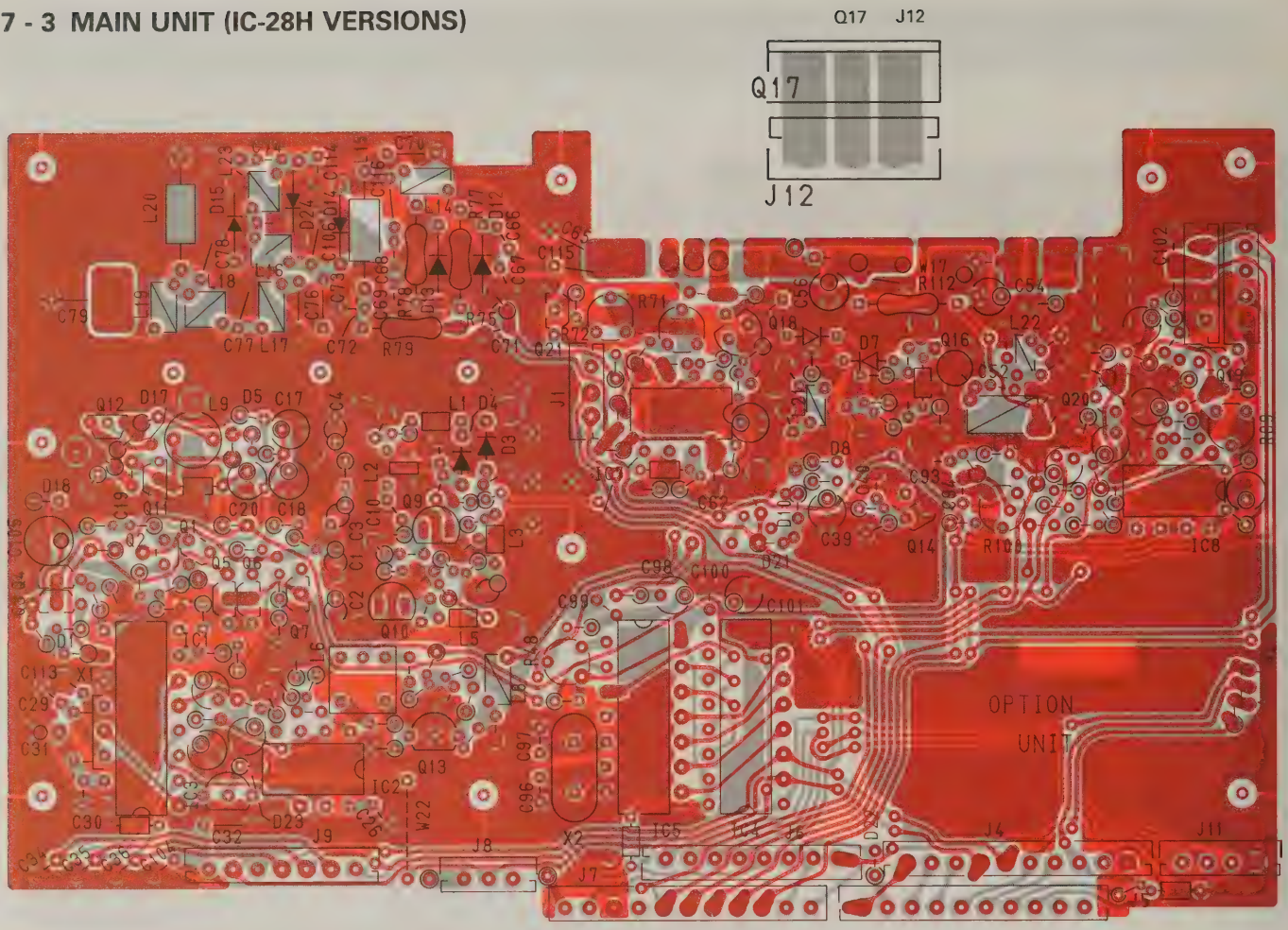
Q10, Q13
2SC2026



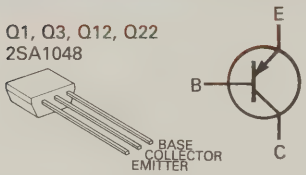
Q16
2SC2407



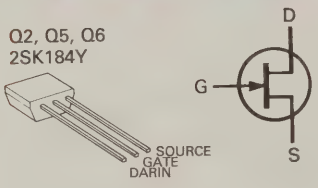
7 - 3 MAIN UNIT (IC-28H VERSIONS)



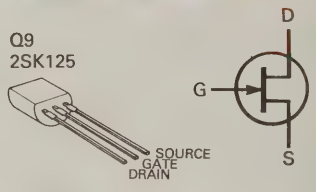
Q1, Q3, Q12, Q22
2SA1048



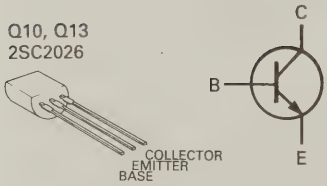
Q2, Q5, Q6
2SK184Y



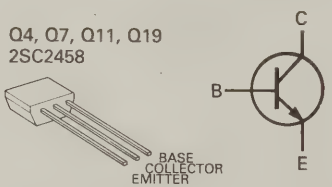
Q9
2SK125



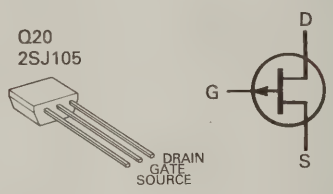
Q10, Q13
2SC2026



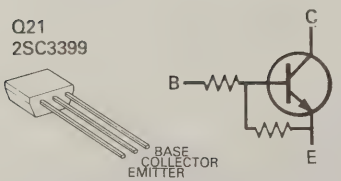
Q4, Q7, Q11, Q19
2SC2458



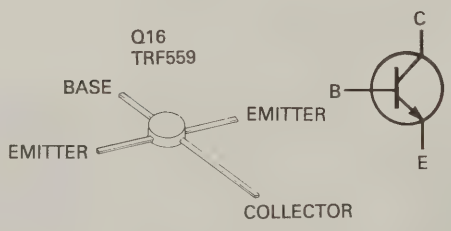
Q20
2SJ105



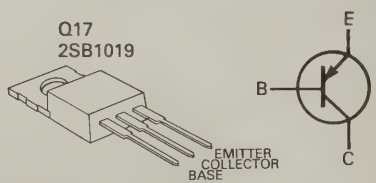
Q21
2SC3399



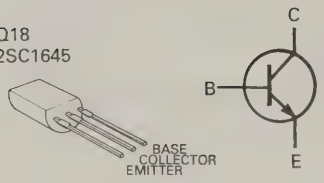
Q16
TRF559



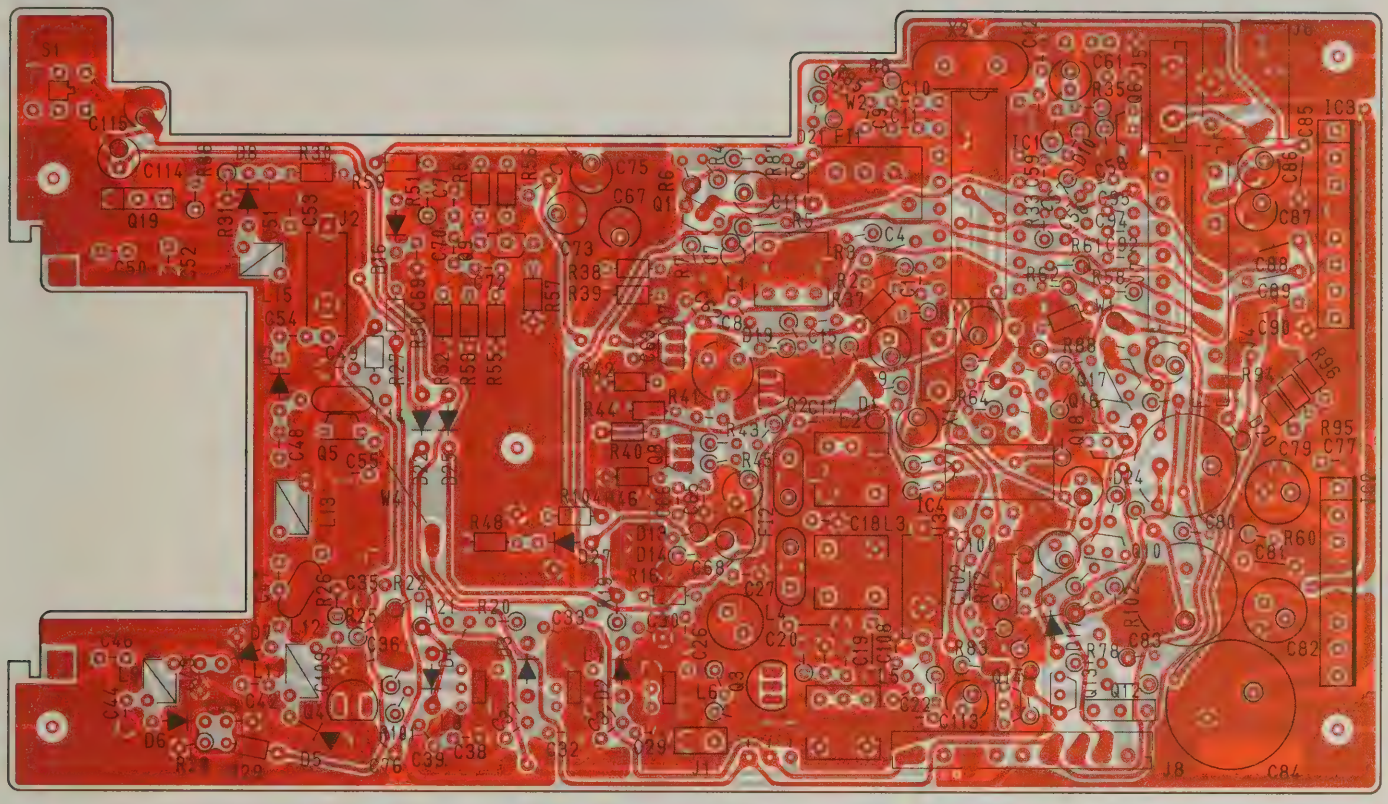
Q17
2SB1019



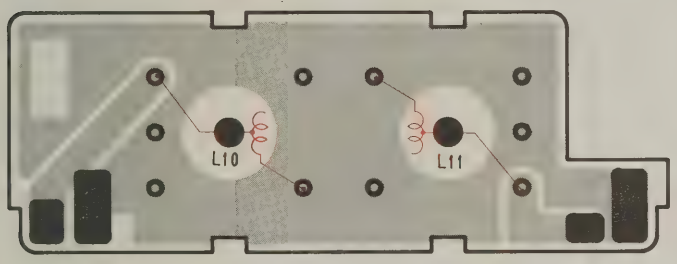
Q18
2SC1645

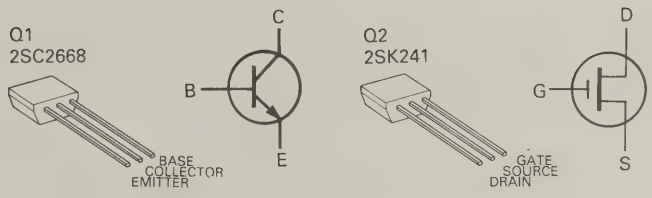


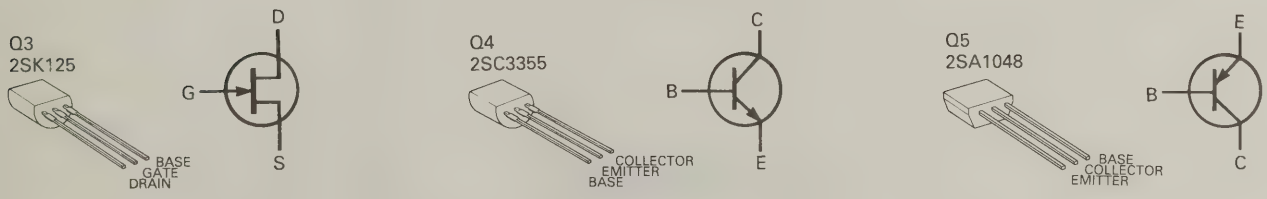
7 - 4 RX UNIT

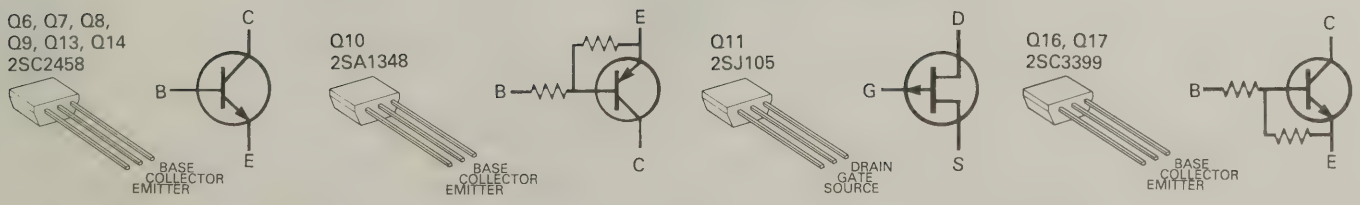


BANDPASS FILTER

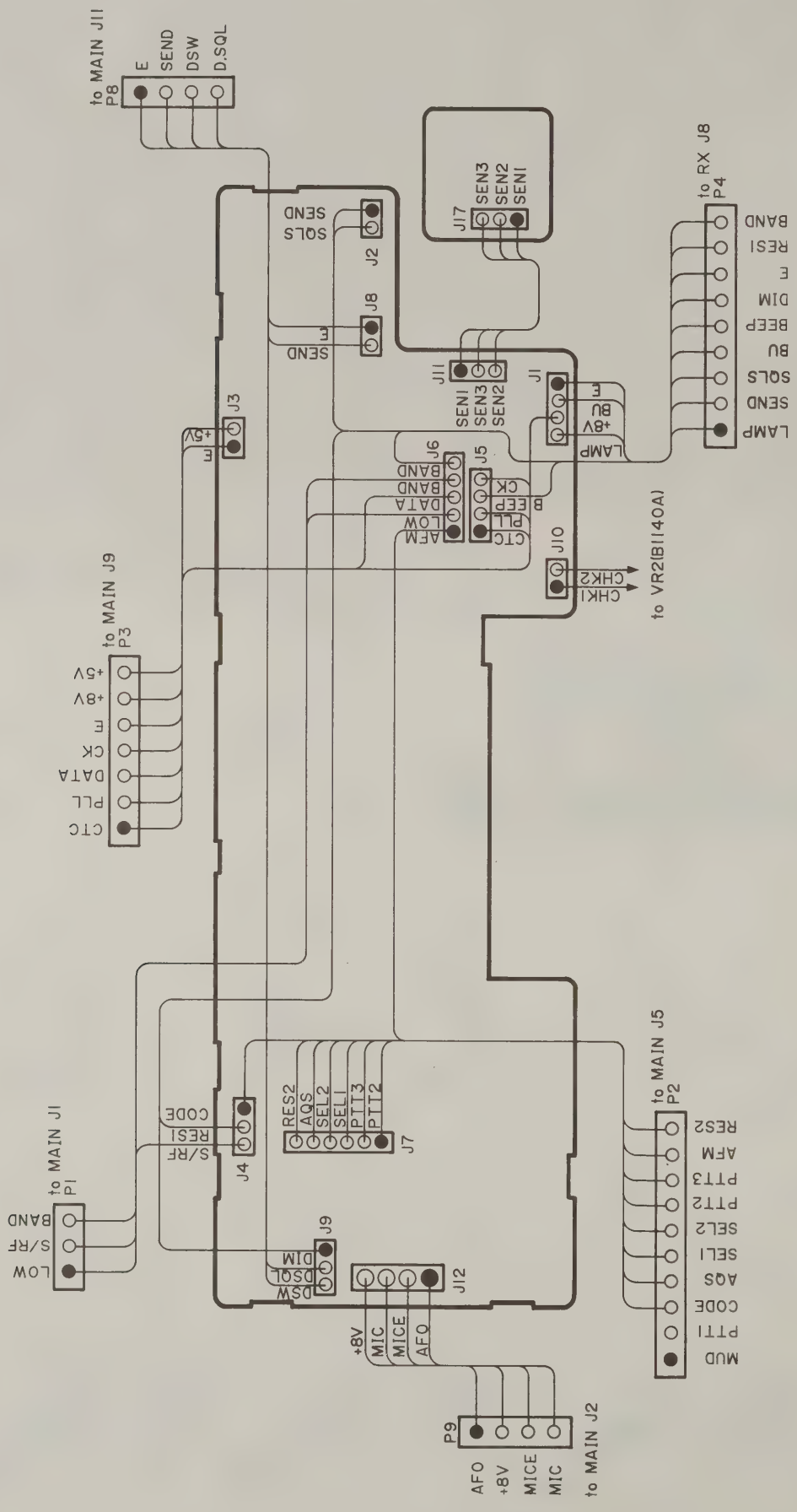


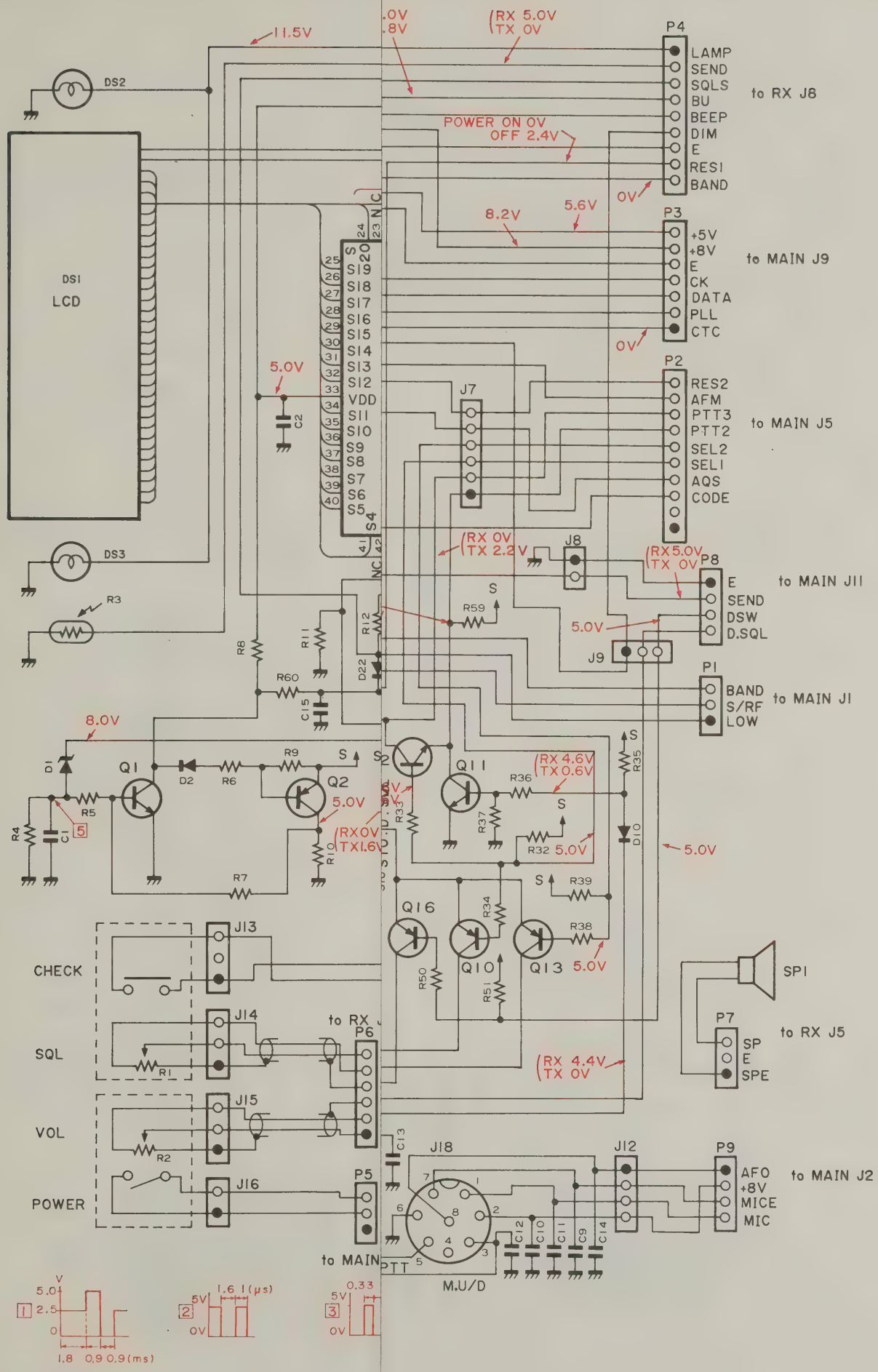




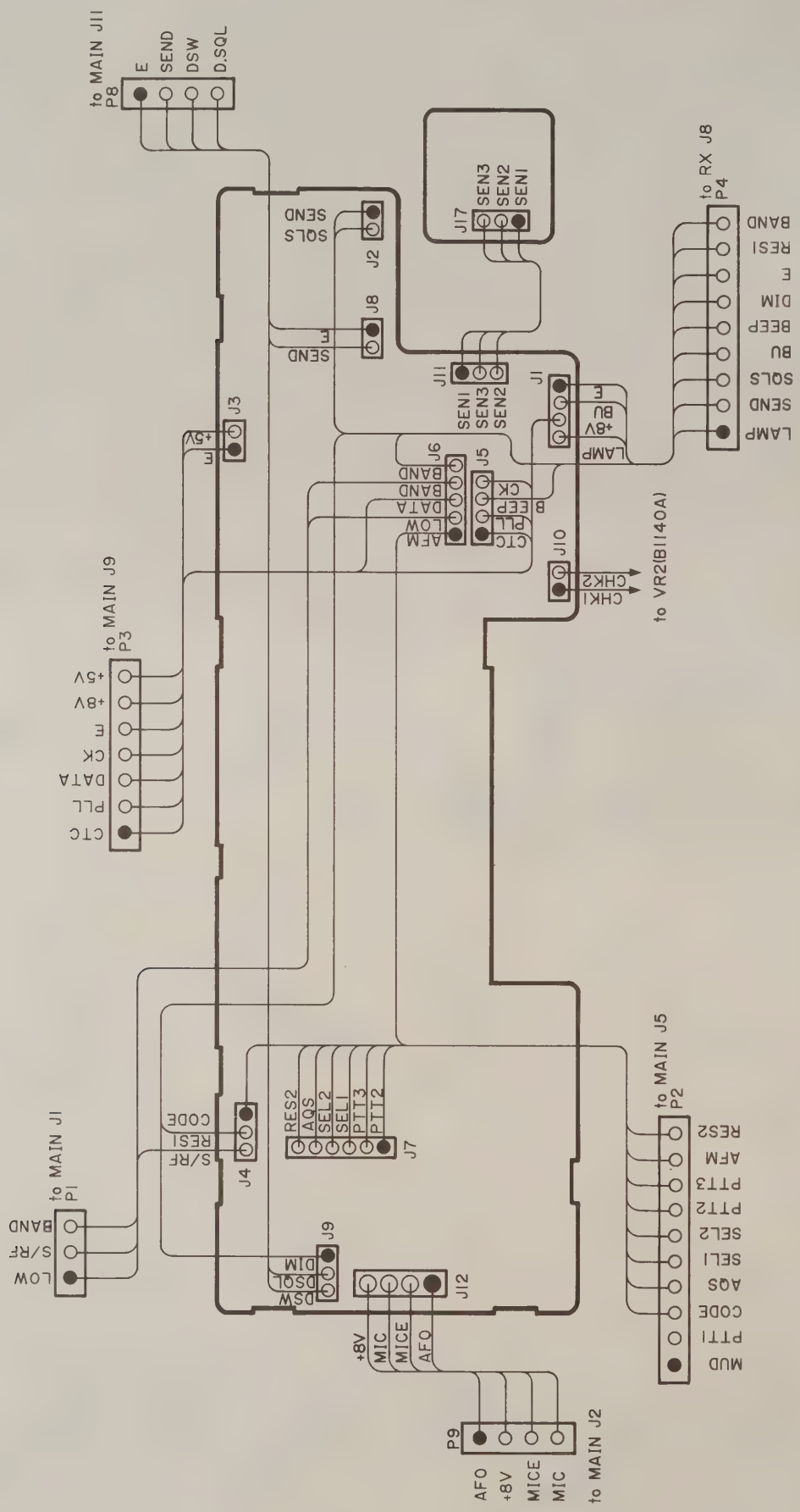


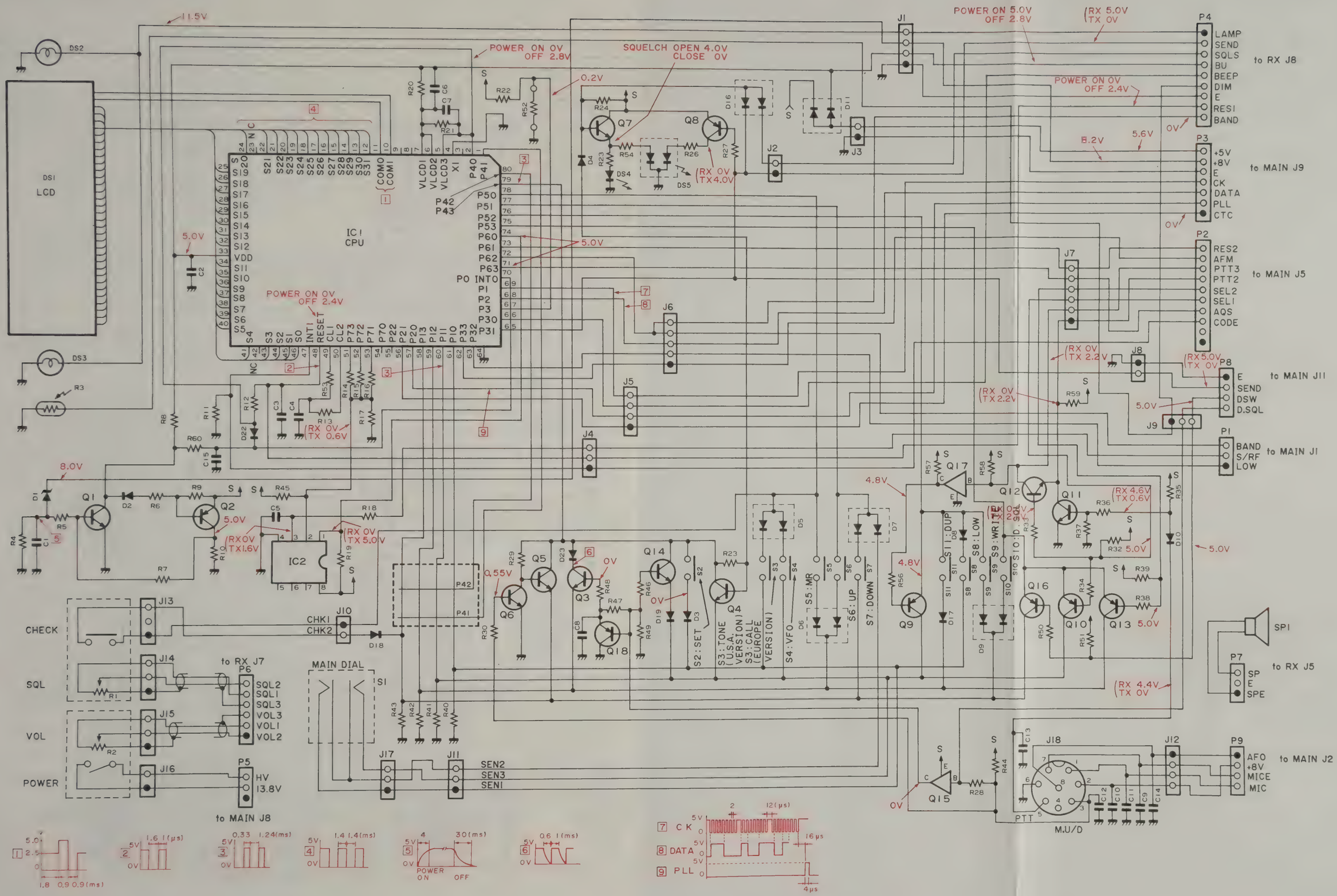
8 - 1 EF UNIT WIRING DIAGRAM

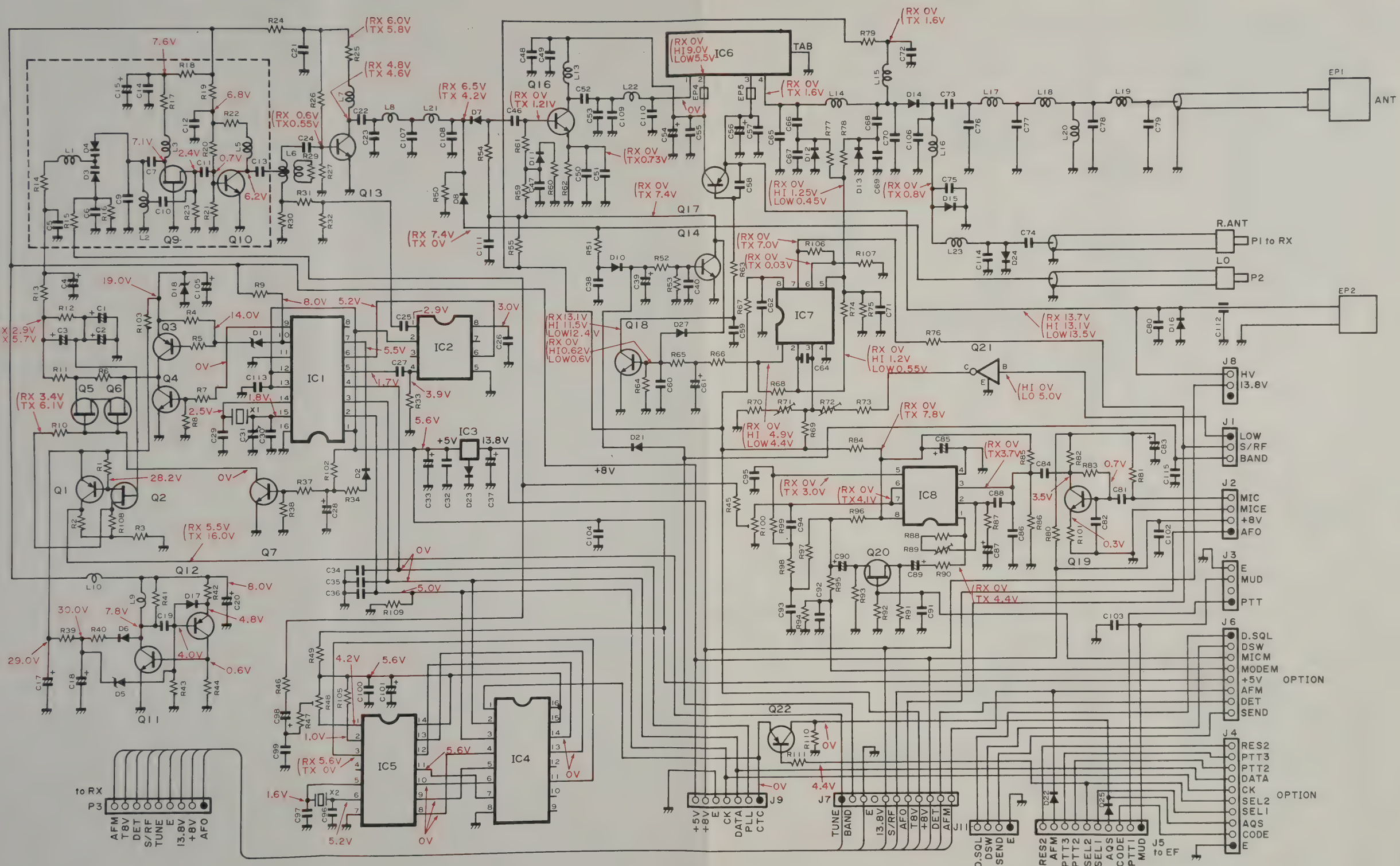


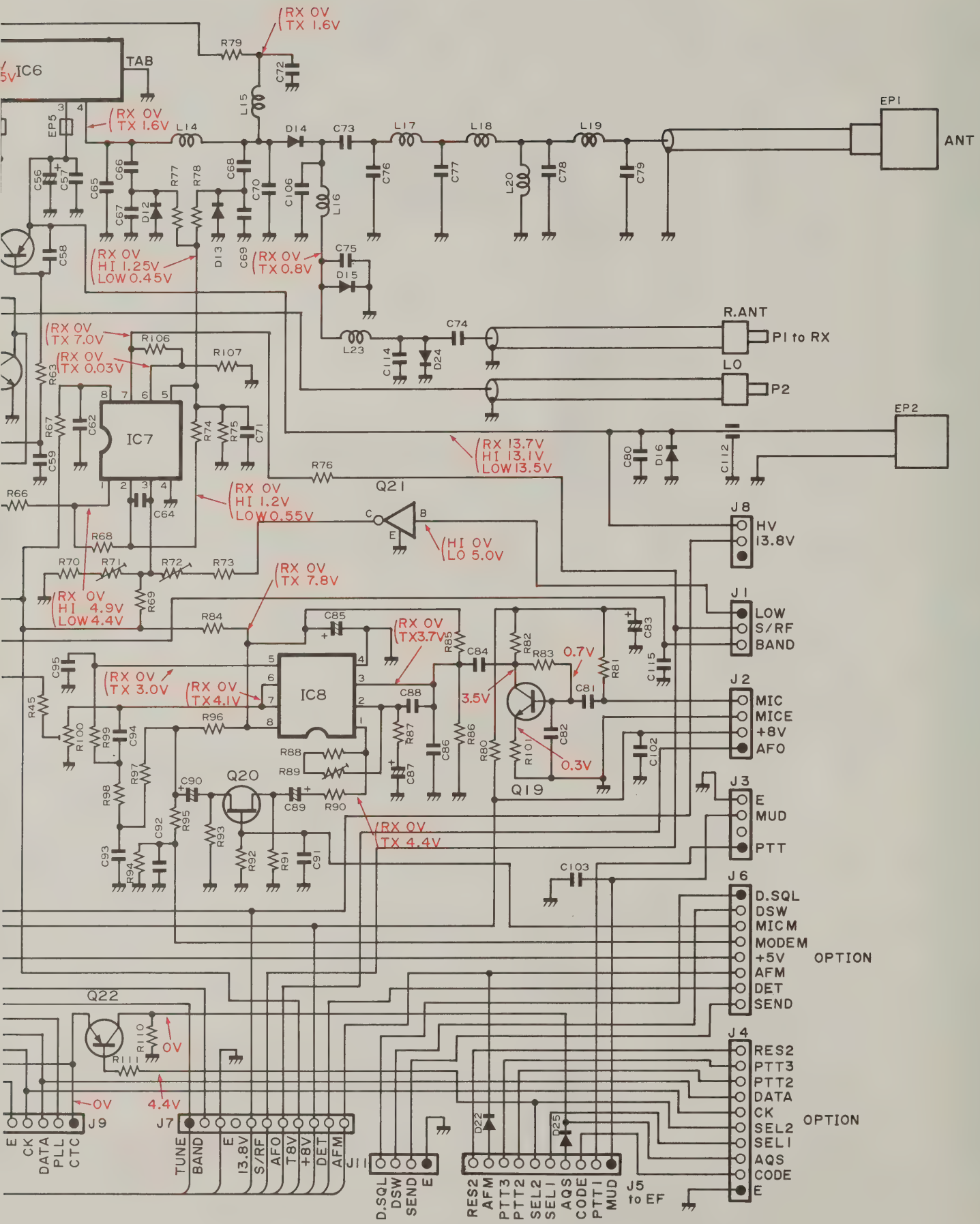

11.5V
.0V
.8V
(RX 5.0V
TX 0V
P4
LAMP
SEND
SQLS
BU
BEEP
DIM
E
RESI
BAND
to RX J8
POWER ON 0V
OFF 2.4V
0V
8.2V
5.6V
P3
+5V
+8V
E
CK
DATA
PLL
CTC
to MAIN J9
0V
P2
RES2
AFM
PTT3
PTT2
SEL2
SELI
AQS
CODE
to MAIN J5
DS2
DS1
LCD
DS3
R3
5.0V
C2
J7
J8
(RX 0V
TX 2.2V
(RX5.0V
TX 0V
P8
E
SEND
DSW
D.SQL
to MAIN JII
S
R59
5.0V
J9
P1
BAND
S/RF
LOW
to MAIN JI
R8
R11
R12
D22
R60
C15
8.0V
D1
Q1
D2
R6
R9
Q2
5.0V
R5
R4
C1
5
R7
R10
(RX0V
TXI.6V
Q11
R36
(RX 4.6V
TX 0.6V
R35
R37
R32 5.0V
D10
5.0V
R39
Q16
Q10
Q13
R34
R38
5.0V
R50
R51
J13
CHECK
J14
SQL
R1
J15
VOL
R2
J16
POWER
to RX
P6
P5
SP1
P7
SP
E
SPE
to RX J5
(RX 4.4V
TX 0V
C13
J18
J12
P9
AFO
+8V
MICE
MIC
to MAIN J2
C12
C10
C11
C9
C14
PTT
M.U/D
to MAIN
V
5.0
2.5
0
1.8
0.9
0.9(ms)
5V
1.6 1(μs)
0V
5V
0.33
0V

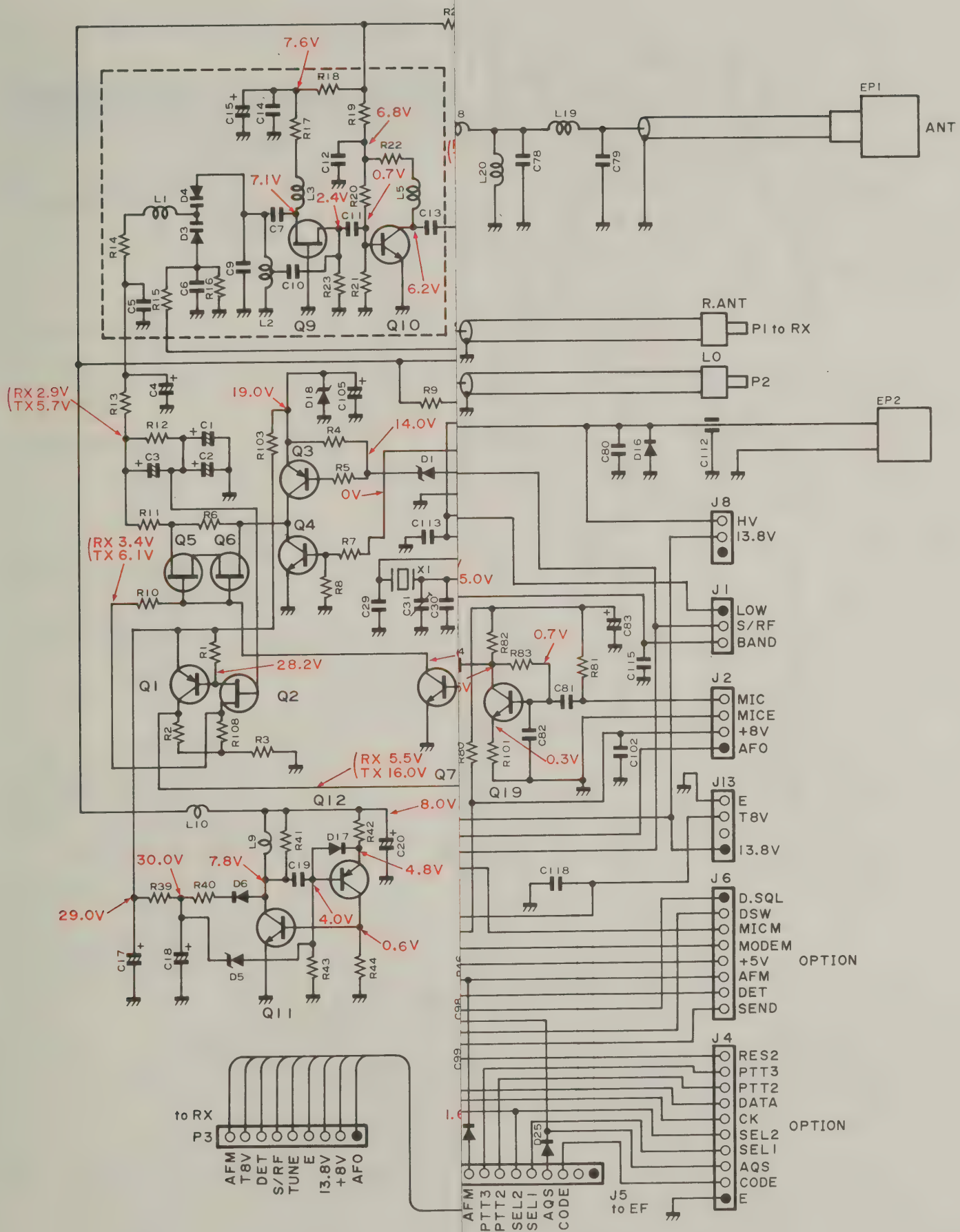
8 - 1 EF UNIT WIRING DIAGRAM

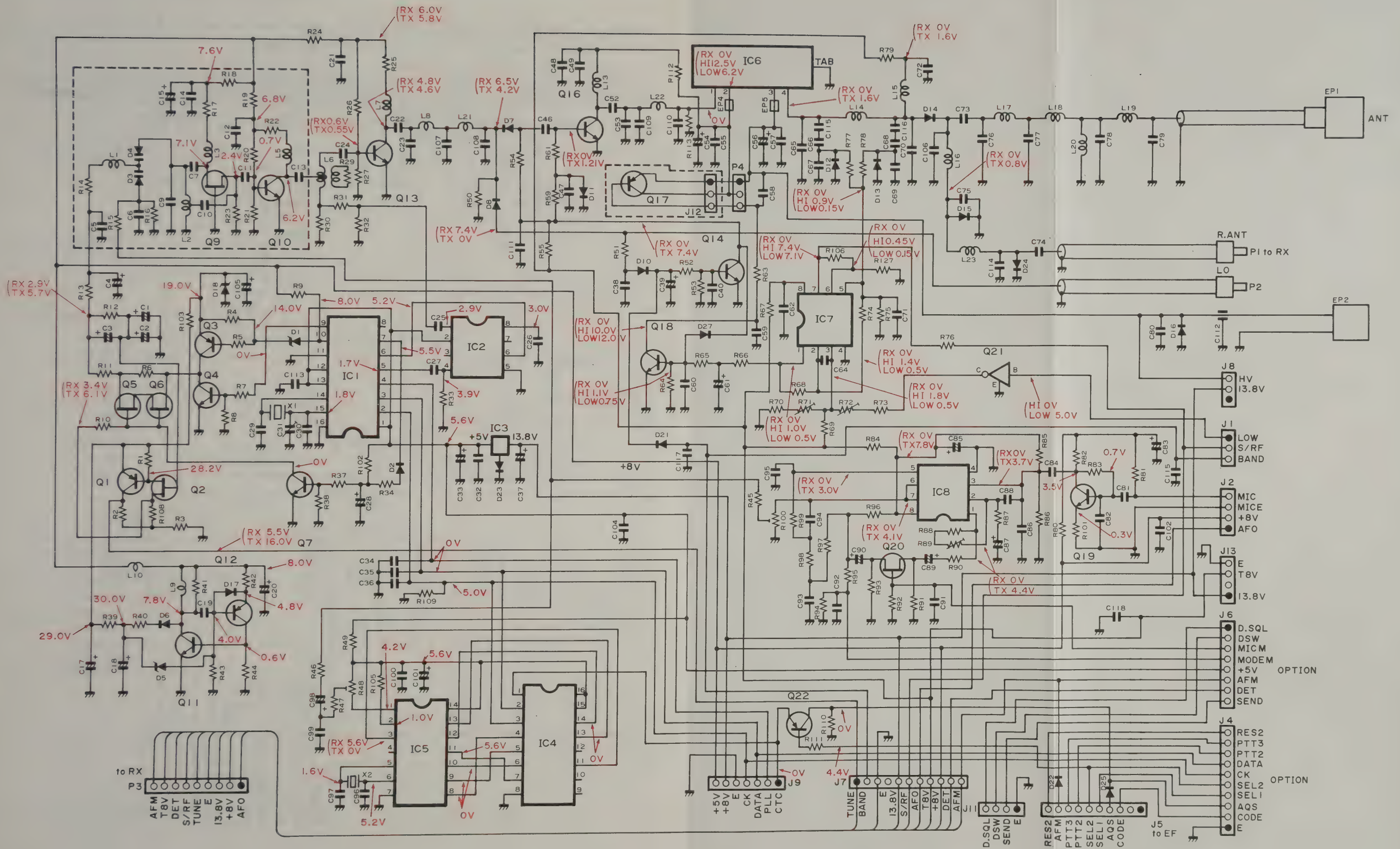


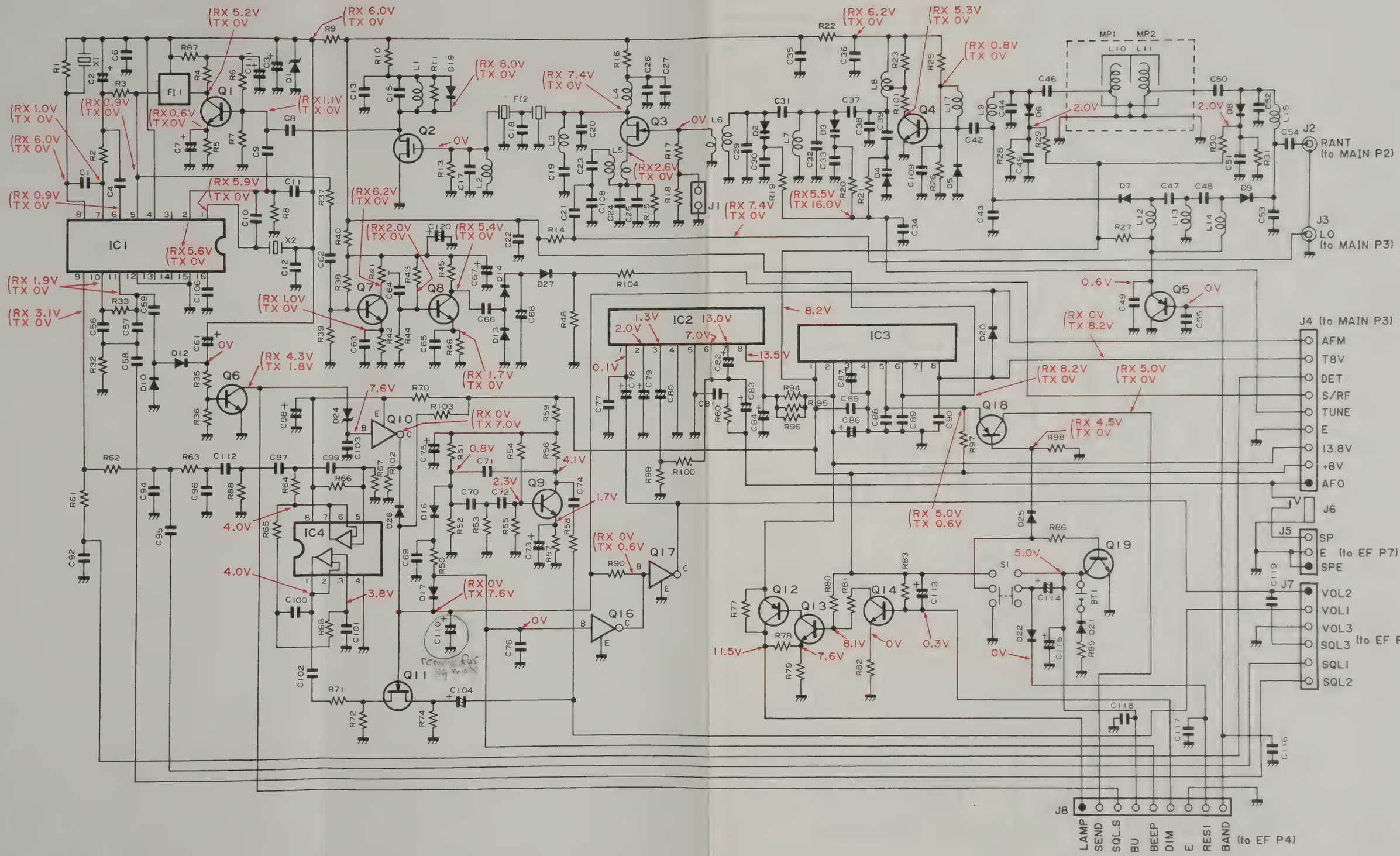

11.5V
DS2
DS1
LCD
DS3
R3
POWER ON 0V
OFF 2.8V
SQUELCH OPEN 4.0V
CLOSE 0V
0.2V
IC1
CPU
5.0V
POWER ON 0V
OFF 2.4V
P42
P43
P50
P51
P52
P53
P60
P61
P62
P63
P0 INT0
P1
P2
P3
P30
P31
P40
P41
S20
S19
S18
S17
S16
S15
S14
S13
S12
VDD
S11
S10
S9
S8
S7
S6
S5
S4
S3
S2
S1
S0
INT1
RESET
CL1
CL2
P73
P72
P71
P70
P22
P21
P20
P13
P12
P11
P10
P33
P32
COM0
COM1
VLCD1
VLCD2
VLCD3
X1
NC
Q7
Q8
Q1
Q2
Q3
Q4
Q5
Q6
Q9
Q10
Q11
Q12
Q13
Q14
Q15
Q16
Q17
Q18
IC2
(RX 0V
TX 0.6V
(RX 0V
TX 1.6V
(RX 0V
TX 5.0V
(RX 0V
TX 4.0V
8.0V
5.0V
0.55V
0V
4.8V
4.6V
(RX 5.0V
TX 0V
POWER ON 5.0V
OFF 2.8V
POWER ON 0V
OFF 2.4V
8.2V
5.6V
(RX 0V
TX 2.2V
(RX 4.6V
TX 0.6V
(RX 4.4V
TX 0V
J1
J2
J3
J4
J5
J6
J7
J8
J9
J10
J11
J12
J13
J14
J15
J16
J17
J18
P1
P2
P3
P4
P5
P6
P7
P8
P9
LAMP
SEND
SQLS
BU
BEEP
DIM
E
RESI
BAND
to RX J8
+5V
+8V
E
CK
DATA
PLL
CTC
to MAIN J9
RES2
AFM
PTT3
PTT2
SEL2
SEL1
AQS
CODE
to MAIN J5
E
SEND
DSW
D.SQL
to MAIN J11
BAND
S/RF
LOW
to MAIN J1
SP
E
SPE
to RX J5
AFO
+8V
MICE
MIC
to MAIN J2
SQL2
SQL1
SQL3
VOL3
VOL1
VOL2
to RX J7
HV
13.8V
to MAIN J8
CHK1
CHK2
SEN2
SEN3
SEN1
CHECK
SQL
VOL
POWER
MAIN DIAL
SP1
PTT
M.U/D
S1:DUP
S2:SET
S3:TONE (U.S.A. VERSION)
S3:CALL (EUROPE VERSION)
S4:VFO
S5:MR
S6:UP
S7:DOWN
S8:LOW
S9:WRITE
S10:D.SQL
S11
7 CK
8 DATA
9 PLL
16µs
4µs
12(µs)
1.8 0.9 0.9(ms)
1.6 1(µs)
0.33 1.24(ms)
1.4 1.4(ms)
4 30(ms)
0.6 1(ms)
POWER ON OFF

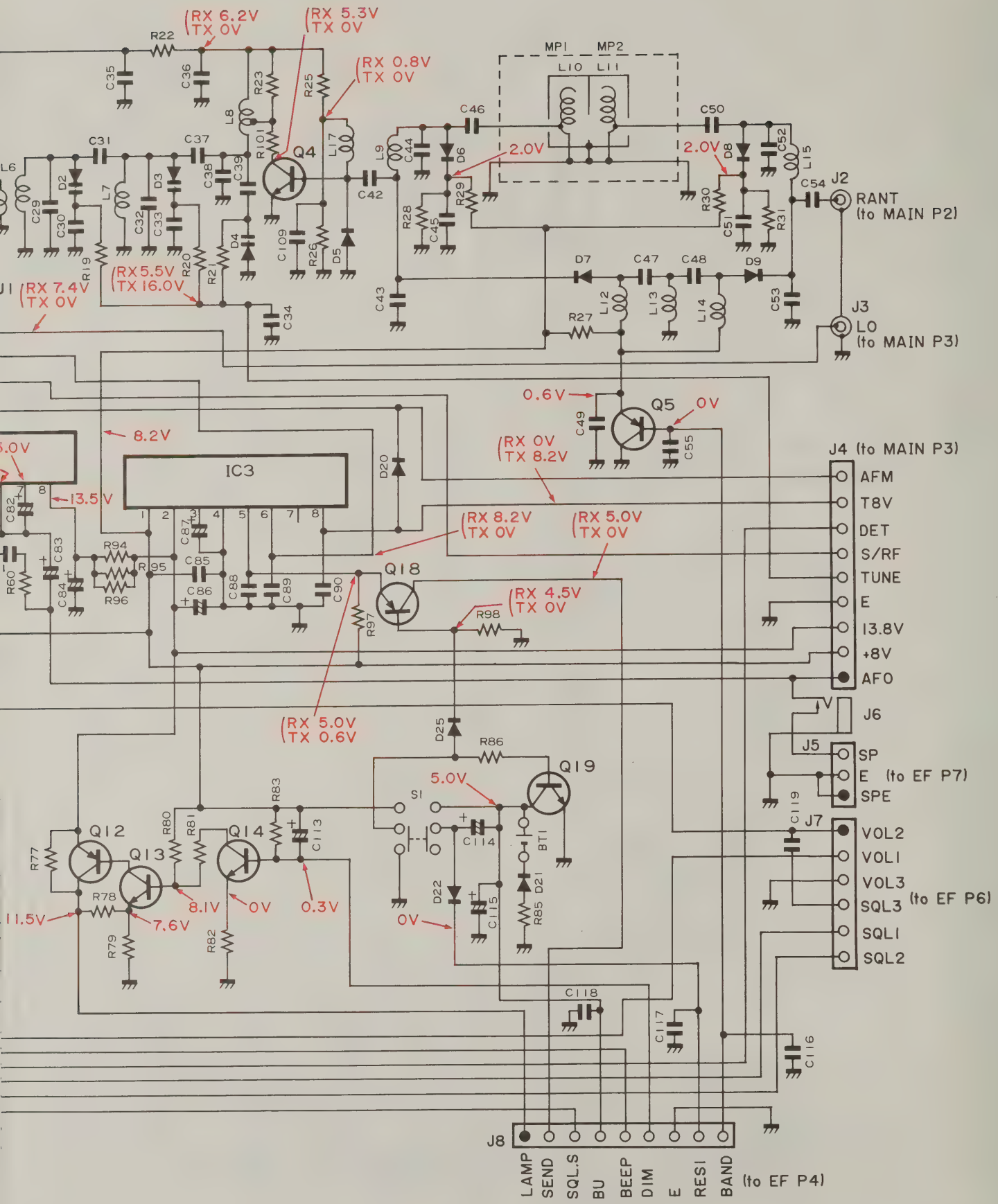

IC1
IC2
IC3
IC4
IC5
IC6
IC7
IC8
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q9
Q10
Q11
Q12
Q13
Q14
Q16
Q17
Q18
Q19
Q20
Q21
Q22
TAB
EP1
ANT
R.ANT
P1 to RX
LO
P2
EP2
J8
HV
13.8V
J1
LOW
S/RF
BAND
J2
MIC
MICE
+8V
AFO
J3
E
MUD
PTT
J6
D.SQL
DSW
MICM
MODEM
+5V
AFM
DET
SEND
OPTION
J4
RES2
PTT3
PTT2
DATA
CK
SEL2
SEL1
AQS
CODE
E
OPTION
J5
to EF
J9
+5V
+8V
E
CK
DATA
PLL
CTC
J7
TUNE
BAND
E
13.8V
S/RF
AFO
T8V
+8V
DET
AFM
J11
D.SQL
DSW
SEND
E
P3
to RX
AFM
T8V
DET
S/RF
TUNE
E
13.8V
+8V
AFO
RX 6.0V
TX 5.8V
RX 4.8V
TX 4.6V
RX 6.5V
TX 4.2V
RX 0V
TX 1.21V
RX 0V
TX0.73V
RX 0V
TX 1.6V
RX 0V
HI 9.0V
LOW5.5V
RX 0V
HI 1.25V
LOW 0.45V
RX 0V
TX 0.8V
RX 0V
TX 7.4V
RX 7.4V
TX 0V
RX 0V
TX 7.0V
RX 0V
TX 0.03V
RX 13.1V
HI 11.5V
LOW12.4V
RX 0V
HI0.62V
LOW0.6V
RX 13.7V
HI 13.1V
LOW13.5V
RX 0V
HI 1.2V
LOW0.55V
HI 0V
LO 5.0V
RX 0V
HI 4.9V
LOW 4.4V
RX 0V
TX 7.8V
RX 0V
TX3.7V
RX 0V
TX 3.0V
RX 0V
TX4.1V
RX 0V
TX 4.4V
RX 0.6V
TX0.55V
RX 5.5V
TX 16.0V
RX 5.6V
TX 0V
7.6V
7.1V
2.4V
0.7V
6.2V
6.8V
19.0V
14.0V
8.0V
5.2V
2.9V
3.0V
5.5V
1.7V
3.9V
5.6V
0V
1.8V
2.5V
3.4V
6.1V
28.2V
0V
8.0V
30.0V
7.8V
4.8V
4.0V
0.6V
29.0V
4.2V
5.6V
1.0V
1.6V
5.2V
0V
+8V
+5V
13.8V
5.0V
0.7V
3.5V
0.3V


IC6
TAB
EP1
ANT
R.ANT
P1 to RX
LO
P2
EP2
IC7
IC8
Q19
Q20
Q21
Q22
J1
LOW
S/RF
BAND
J2
MIC
MICE
+8V
AFO
J3
E
MUD
PTT
J4
RES2
PTT3
PTT2
DATA
CK
SEL2
SEL1
AQS
CODE
E
OPTION
J5
to EF
J6
D.SQL
DSW
MICM
MODEM
+5V
AFM
DET
SEND
OPTION
J7
TUNE
BAND
E
13.8V
S/RF
AFO
T8V
+8V
DET
AFM
J8
HV
13.8V
J9
E
CK
DATA
PLL
CTC
RX 0V
TX 1.6V
RX 0V
HI 1.25V
LOW 0.45V
RX 0V
TX 0.8V
RX 0V
TX 7.0V
RX 0V
TX 0.03V
RX 13.7V
HI 13.1V
LOW 13.5V
RX 0V
HI 1.2V
LOW 0.55V
HI 0V
LO 5.0V
RX 0V
TX 7.8V
RX 0V
HI 4.9V
LOW 4.4V
RX 0V
TX 3.7V
RX 0V
TX 3.0V
RX 0V
TX 4.1V
3.5V
0.7V
0.3V
RX 0V
TX 4.4V
0V
4.4V
0V


7.6V
6.8V
7.1V
2.4V
0.7V
6.2V
Q9
Q10
L2
EP1
ANT
L19
R.ANT
P1 to RX
L0
P2
EP2
(RX 2.9V
TX 5.7V
19.0V
14.0V
0V
(RX 3.4V
TX 6.1V
5.0V
28.2V
Q1
Q2
Q3
Q4
Q5
Q6
Q7
(RX 5.5V
TX 16.0V
0.7V
0.3V
Q19
8.0V
Q12
Q11
30.0V
7.8V
4.8V
29.0V
4.0V
0.6V
J8
HV
13.8V
J1
LOW
S/RF
BAND
J2
MIC
MICE
+8V
AFO
J13
E
T8V
13.8V
J6
D.SQL
DSW
MICM
MODEM
+5V
AFM
DET
SEND
OPTION
J4
RES2
PTT3
PTT2
DATA
CK
SEL2
SEL1
AQS
CODE
E
OPTION
to RX
P3
AFM
T8V
DET
S/RF
TUNE
E
13.8V
+8V
AFO
J5
to EF
AFM
PTT3
PTT2
SEL2
SEL1
AQS
CODE


IC1
IC2
IC3
IC4
IC5
IC6
IC7
IC8
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q9
Q10
Q11
Q12
Q13
Q14
Q16
Q17
Q18
Q19
Q20
Q21
Q22
TAB
P3
P4
J1
J2
J6
J7
J8
J9
J11
J12
J13
EP1
EP2
EP4
EP5
ANT
R.ANT
LO
P1 to RX
P2
HV 13.8V
LOW S/RF BAND
MIC MICE +8V AFO
E T8V 13.8V
D.SQL DSW MICM MODEM +5V AFM DET SEND
OPTION
RES2 PTT3 PTT2 DATA CK SEL2 SEL1 AQS CODE E
OPTION
J5 to EF
to RX
AFM T8V DET S/RF TUNE E 13.8V +8V AFO
+5V +8V E CK DATA PLL CTC
TUNE BAND E 13.8V S/RF AFO T8V +8V DET AFM
D.SQL DSW SEND E
RES2 AFM PTT3 PTT2 SEL2 SEL1 AQS CODE
7.6V
6.8V
7.1V
12.4V
0.7V
6.2V
(RX 6.0V TX 5.8V)
(RX 4.8V TX 4.6V)
(RX 6.5V TX 4.2V)
(RX0.6V TX0.55V)
(RX 7.4V TX 0V)
(RX 0V TX1.21V)
(RX 0V HI12.5V LOW6.2V)
(RX 0V TX 1.6V)
(RX 0V TX 0.8V)
(RX 0V HI 0.9V LOW0.15V)
(RX 0V TX 7.4V)
(RX 0V HI 7.4V LOW7.1V)
(RX 0V HI0.45V LOW 0.15V)
(RX 0V HI 1.4V LOW 0.5V)
(RX 0V HI 1.8V LOW 0.5V)
HI 0V LOW 5.0V
(RX 0V HI 1.0V LOW 0.5V)
(RX 0V HI10.0V LOW12.0V)
(RX 0V HI 1.1V LOW0.75V)
(RX 0V TX7.8V)
(RX0V TX3.7V)
(RX 0V TX 3.0V)
(RX 0V TX 4.1V)
(RX 0V TX 4.4V)
(RX 2.9V TX 5.7V)
(RX 3.4V TX 6.1V)
(RX 5.5V TX 16.0V)
(RX 5.6V TX 0V)
19.0V
14.0V
8.0V
5.2V
2.9V
3.0V
5.5V
1.7V
1.8V
3.9V
5.6V
+5V
13.8V
28.2V
0V
30.0V
7.8V
4.0V
4.8V
0.6V
29.0V
4.2V
5.6V
1.0V
1.6V
5.2V
0V
5.0V
8.0V
4.4V
0.7V
0.3V
3.5V


IC1
IC2 13.0V
IC3
IC4
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11
Q12
Q13
Q14
Q16
Q17
Q18
Q19
FI1
FI2
J1
J2 RANT (to MAIN P2)
J3 LO (to MAIN P3)
J4 (to MAIN P3)
AFM
T8V
DET
S/RF
TUNE
E
13.8V
+8V
AFO
J5
SP
E (to EF P7)
SPE
J6
J7
VOL2
VOL1
VOL3
SQL3 (to EF P6)
SQL1
SQL2
J8
LAMP
SEND
SQL.S
BU
BEEP
DIM
E
RESI
BAND (to EF P4)
MP1
MP2
(RX 5.2V TX 0V)
(RX 6.0V TX 0V)
(RX 8.0V TX 0V)
(RX 7.4V TX 0V)
(RX 6.2V TX 0V)
(RX 5.3V TX 0V)
(RX 0.8V TX 0V)
(RX 1.0V TX 0V)
(RX 0.9V TX 0V)
(RX 0.6V TX 0V)
(RX 1.1V TX 0V)
(RX 6.0V TX 0V)
(RX 0.9V TX 0V)
(RX 5.9V TX 0V)
(RX 5.6V TX 0V)
(RX 6.2V TX 0V)
(RX 2.0V TX 0V)
(RX 5.4V TX 0V)
(RX 2.6V TX 0V)
(RX 5.5V TX 16.0V)
(RX 7.4V TX 0V)
(RX 1.9V TX 0V)
(RX 3.1V TX 0V)
(RX 1.0V TX 0V)
(RX 1.7V TX 0V)
(RX 4.3V TX 1.8V)
(RX 0V TX 7.0V)
(RX 0V TX 0.6V)
(RX 0V TX 7.6V)
(RX 8.2V TX 0V)
(RX 5.0V TX 0V)
(RX 4.5V TX 0V)
(RX 5.0V TX 0.6V)
(RX 0V TX 8.2V)
0.6V
2.0V
8.2V
13.5V
0.1V
1.3V
7.0V
0.8V
4.1V
2.3V
1.7V
4.0V
3.8V
11.5V
8.1V
0V
0.3V
5.0V
7.6V


(RX 6.2V TX 0V
(RX 5.3V TX 0V
(RX 0.8V TX 0V
MP1 MP2
L10 L11
R22
C35 C36
L8
R23 R25
C46
C50
C31 C37
Q4
L9 C44 D6
2.0V
2.0V
D8
C52 L15
L6 D2 L7 D3
C29 C30 C32 C33
C38 C39
R10
L17
C54 J2
RANT
(to MAIN P2)
R29
R28 C45
R30 C51 R31
D4 C109 R26 D5
C42
D7 C47 C48 D9
R19 R20 R21
(RX 5.5V TX 16.0V
(RX 7.4V TX 0V
C43
L12 L13 L14
C53
R27
J3
LO
(to MAIN P3)
C34
0.6V
Q5
0V
C49
C55
8.2V
(RX 0V TX 8.2V
J4 (to MAIN P3)
AFM
T8V
DET
S/RF
TUNE
E
13.8V
+8V
AFO
IC3
D20
13.5V
C82
C87
C83
R94
R95
C85
C86
C88
C89
C90
R60
C84
R96
Q18
R97
R98
(RX 8.2V TX 0V
(RX 5.0V TX 0V
(RX 4.5V TX 0V
(RX 5.0V TX 0.6V
D25
R86
Q19
5.0V
S1
C114
BT1
D22
C115
R85 D21
0V
J6
J5
SP
E (to EF P7)
SPE
C119
J7
VOL2
VOL1
VOL3
SQL3 (to EF P6)
SQL1
SQL2
Q12
Q13
Q14
R77
R78
R79
R80
R81
R82
R83
C113
11.5V
8.1V
0V
0.3V
7.6V
C118
C117
C116
J8
LAMP
SEND
SQL.S
BU
BEEP
DIM
E
RESI
BAND
(to EF P4)

SECTION 9 TROUBLESHOOTING

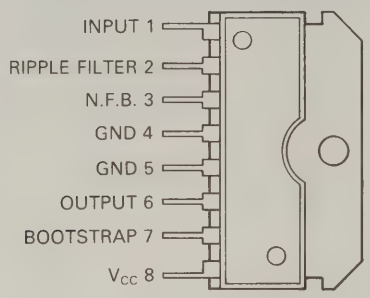
The following chart is designed to help you correct problems which are not equipment malfunctions. If you are not able to locate the cause of the problem or to solve it through the use of this chart, contact your nearest authorized ICOM Dealer or Service Center.

PROBLEM	POSSIBLE CAUSE	SOLUTION
1. Power does not come on when the VOL/PWR CONTROL is pushed ON.	• Power cable is improperly connected. • Power connector is making poor contact. • Polarity of the power connection is wrong. • Blown fuse.	• Carefully reconnect power cable. • Check the connector pins. • Disconnect the power cable, replace the blown fuse, then reconnect the power cable observing proper polarity. • Check for the cause, then replace the fuse.
2. No sound comes from the speaker.	• Volume setting is too low. • SQUELCH CONTROL is set incorrectly. • External speaker is connected.	• Set volume to an appropriate level. • Adjust squelch so the noise from the speaker is just quieted while receiving no signal. • Check that the external speaker plug is inserted properly, and that the external speaker cable is not cut.
3. Sensitivity is low and only strong signals are audible.	• Antenna feedline is cut or short circuited.	• Check, and if necessary replace, the feedling.
4. No or low RF output.	• The LOW position is selected with the HI/LO SWITCH. • PTT SWITCH on the microphone is not operating due to poor connection of the MIC CONNECTOR.	• Push the HI/LO SWITCH to select the HIGH output power position. • Check the connector pins on the MIC CONNECTOR.
5. No modulation of the transmitter.	• Poor connection of the MIC CONNECTOR.	• Check the connector pins on the MIC CONNECTOR.
6. Frequency does not change when the TUNING CONTROL is turned.	• MEMORY mode is selected.	• Select the VFO mode by using the VFO/MR SWITCH.
7. An abnormal, out-of-band frequency is displayed on the front panel DISPLAY.	• CPU malfunction. • Lithium backup battery is exhausted.	• Reset the CPU (microcomputer). Refer to SECTION 5-8 in the IC-28A/E/H instruction manual. • Take your IC-28A/E/H to an authorized ICOM Dealer or Service Center.
8. Scan functions do not stop even when signals are received.	• SQL/CHK CONTROL is set incorrectly.	• Adjust squelch so the noise from the speaker is just quieted while receiving no signal.
9. Memory channel frequencies change after resetting the CPU.	• All memories are initialized after the CPU is reset.	• Re-program the memory channels after the CPU is reset.

10 - 1 LINEAR ICs

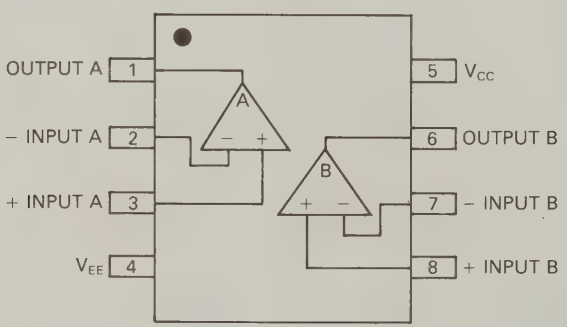
μPC1241H (AUDIO POWER AMPLIFIER)

PIN CONNECTIONS (Top View)



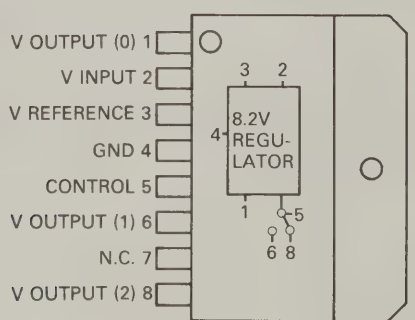
NJM4558D (DUAL LOW NOISE OPERATIONAL AMPLIFIER)
LA6393M (DUAL COMPARATOR)
μPC358C (DUAL DRIVER)

PIN CONNECTIONS (Top View)



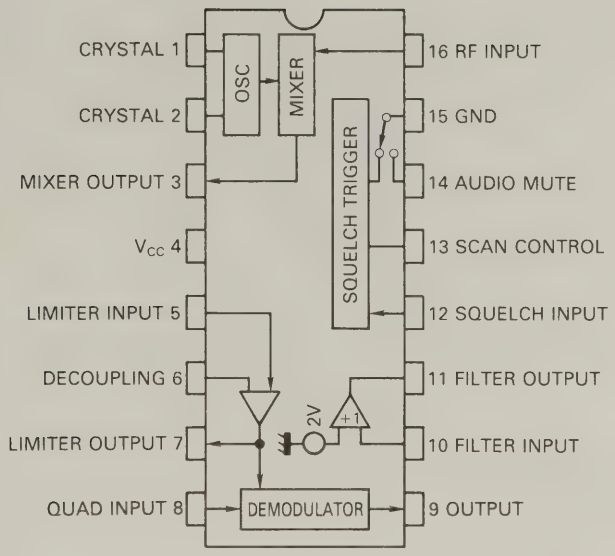
MB3756 (3-OUTPUT 8.2 V VOLTAGE REGULATOR)

PIN CONNECTIONS



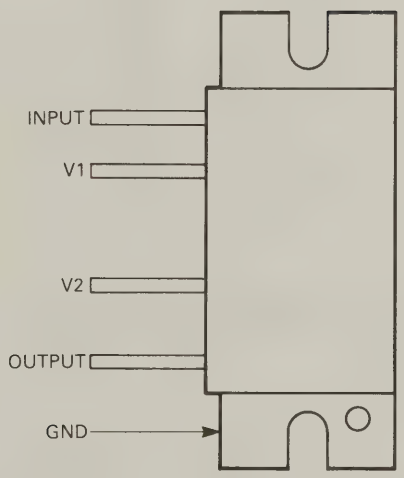
MC3357P (NARROW BAND FM IF)

PIN CONNECTIONS (Top View)



SC-1019 (25W VHF RF POWER AMPLIFIER)
SC-1022 (45W VHF RF POWER AMPLIFIER)

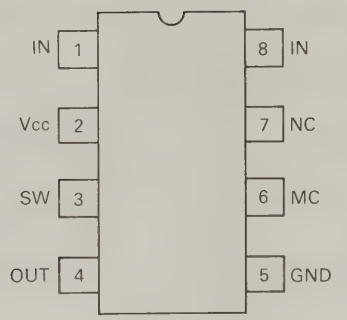
PIN CONNECTIONS



10 - 2 LOGIC ICs

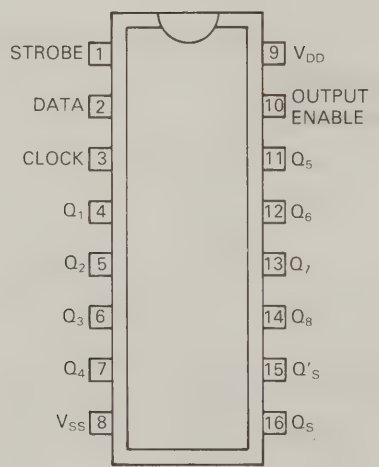
MB504 (HIGH SPEED PRESCALER)

PIN CONNECTIONS (Top View)



μPD4094 (8-STAGE SHIFT REGISTER)

PIN CONNECTIONS (Top View)

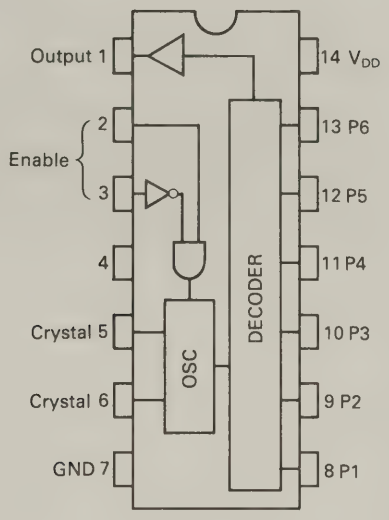


MB87001 (CMOS SERIAL INPUT PLL FREQUENCY SYNTHESIZER)

PIN CONNECTIONS (Top View)

S-7116A (PROGRAMMABLE TONE GENERATOR)

PIN CONNECTIONS (Top View)



PROGRAMMING TABLE

TONE FREQUENCY	P1	P2	P3	P4	P5	P6
67.0	1					
71.9		1				
74.4	1	1				
77.0			1			
79.7	1		1			
82.5		1	1			
85.4	1	1	1			
88.5				1		
91.5	1			1		
94.8		1		1		
97.4	1	1		1		
100.0			1	1		
103.5	1		1	1		
107.2		1	1	1		
110.9	1	1	1	1		
114.8					1	
118.8	1				1	
123.0		1			1	
127.3	1	1			1	
131.8			1		1	

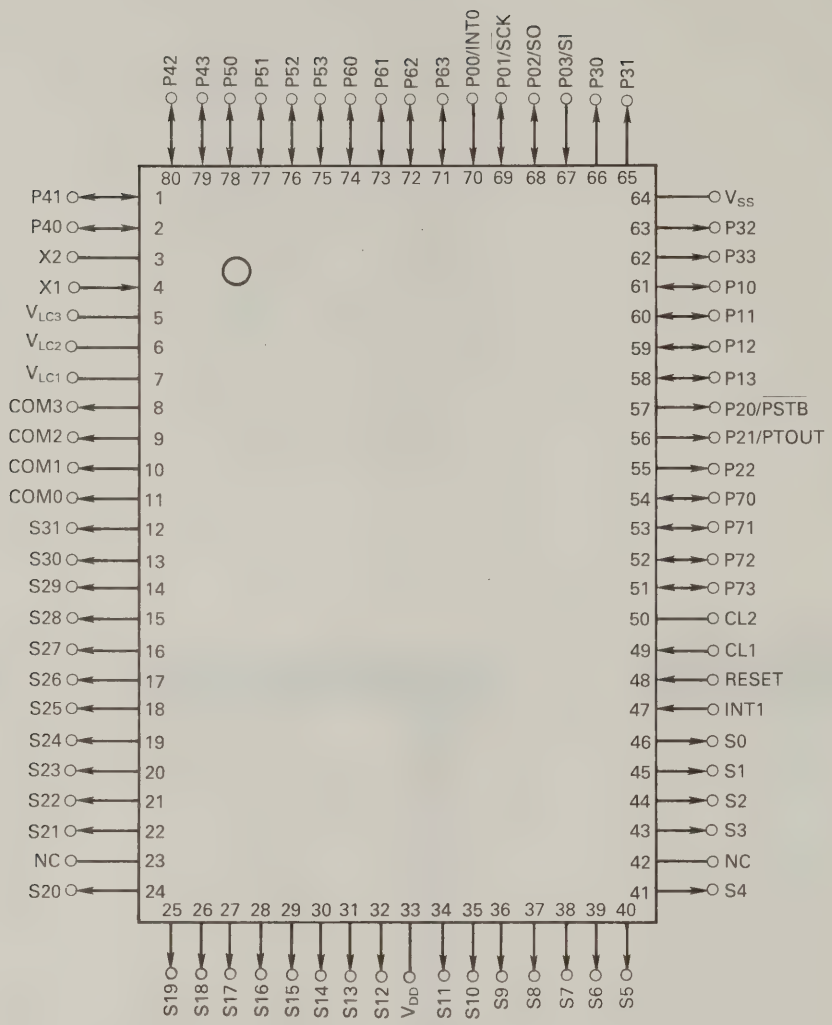
TONE FREQUENCY	P1	P2	P3	P4	P5	P6
136.5	1		1		1	
141.3		1	1		1	
146.2	1	1	1		1	
151.4				1	1	
156.7	1			1	1	
162.2		1		1	1	
167.9	1	1		1	1	
173.8			1	1	1	
179.9	1		1	1	1	
186.2		1	1	1	1	
192.8	1	1	1	1	1	
203.5						1
210.7	1					1
218.1		1				1
225.7	1	1				1
233.6			1			1
241.8	1		1			1
250.3		1	1			1

TONE FREQUENCY	P1	P2	P3	P4	P5	P6
500	1	1	1			1
600				1		1
700	1			1		1
800		1		1		1
900	1	1		1		1
1000			1	1		1
1600	1		1	1		1
1700		1	1	1		1
1750	1	1	1	1		1
1800					1	1
1300	1				1	1
2000		1			1	1
2200	1	1			1	1
2975			1		1	1
2550	1		1		1	1
2295		1	1		1	1
2125	1	1	1		1	1
1275				1	1	1
1445	1			1	1	1

1 : V_{DD}
Blank : Ground or Open
Crystal frequency : 3.579545MHz

μPD1514G (MOS DIGITAL IC)

PIN CONNECTIONS (Top View)



SECTION 11 PARTS LIST

NOTE: All parts listed for IC-28A/E are the same in the IC-28H version unless otherwise stated.

11 - 1 EF UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	
IC1	IC	µPD7514G-191-12	
IC2	IC	LA6393M	
Q1	Transistor	2SC2712-Y	
Q2	Transistor	2SA1162-Y	
Q3	Transistor	2SC2712-Y	
Q4	Transistor	2SC2712-Y	
Q5	Transistor	2SC2712-Y	
Q6	Transistor	2SC2712-Y	
Q7	Transistor	2SC2712-Y	
Q8	Transistor	2SA1162-Y	
Q9	Transistor	2SA1162-Y	
Q10	Transistor	2SA1162-Y	
Q11	Transistor	2SC2712-Y	
Q12	Transistor	2SC2712-Y	
Q13	Transistor	2SA1162-Y	
Q14	Transistor	2SC2712-Y	
Q15	Transistor	2SA1341	
Q16	Transistor	2SA1162-Y	
Q17	Transistor	2SC3395	
Q18	Transistor	2SA1162-Y	
D1	Zener	RD5.6M B2	
D2	Diode	1SS190	
D3	Diode	1SS190	
D4	Diode	1SS193	
D5	Diode	1SS181	
D6	Diode	1SS184	
D7	Diode	1SS181	
D8	Diode	1SS190	
D9	Diode	1SS184	
D10	Diode	1SS193	
D11	Diode	1SS181	
D12	Diode	1SS181	
D14	Diode	1SS181	(#01)
D14	Diode	1SS187	(#03, #04)
D15	Diode	1SS190	(#03, #05)
D16	Diode	1SS181	
D17	Diode	1SS190	
D18	Diode	1SS190	
D19	Diode	1SS190	
D22	Diode	1SS193	
D23	Diode	1SS193	
R1	Variable	RK0941114	(10KB)
R2	Variable	RK9A12	(10KA)
R3	CDS	MPY-43C79	
R4	Chip	10k	MCR10
R5	Chip	10k	MCR10
R6	Chip	220k	MCR10
R7	Chip	270k	MCR10
R8	Chip	10k	MCR10
R9	Chip	100k	MCR10
R10	Chip	10k	MCR10
R11	Chip	100k	MCR10

EF UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)		
R12	Chip	1M	MCR10	
R13	Chip	100k	MCR10	
R14	Chip	47k	MCR10	
R15	Chip	100k	MCR10	
R16	Chip	220k	MCR10	
R17	Chip	8.2k	MCR10	
R18	Chip	100k	MCR10	
R19	Chip	100k	MCR10	
R20	Chip	270k	MCR10	
R21	Chip	270k	MCR10	
R22	Chip	100k	MCR10	
R23	Chip	100k	MCR10	
R24	Chip	3.3k	MCR10	
R26	Chip	330	MCR10	
R27	Chip	22k	MCR10	
R28	Chip	100k	MCR10	
R29	Chip	100k	MCR10	
R30	Chip	100k	MCR10	
R32	Chip	10k	MCR10	
R33	Chip	470k	MCR10	
R34	Chip	100k	MCR10	
R35	Chip	2.2k	MCR10	
R36	Chip	22k	MCR10	
R37	Chip	10k	MCR10	
R38	Chip	100k	MCR10	
R39	Chip	100k	MCR10	
R40	Chip	100k	MCR10	
R41	Chip	100k	MCR10	
R42	Chip	100k	MCR10	
R43	Chip	100k	MCR10	
R44	Chip	1k	MCR10	
R45	Chip	220k	MCR10	
R46	Chip	470k	MCR10	
R47	Chip	220k	MCR10	
R48	Chip	1M	MCR10	
R49	Chip	10k	MCR10	
R50	Chip	100k	MCR10	
R51	Chip	100k	MCR10	
R52	Resistor	4.7k	R20	(#03, #04, #05)
R53	Chip	3.3k	MCR10	
R54	Chip	150	MCR10	
R56	Chip	100k	MCR10	
R57	Chip	470k	MCR10	
R58	Chip	100k	MCR10	
R59	Chip	470k	MCR10	
R60	Chip	56k	MCR10	
C1	Monolithic	0.1	GRM40 F	
C2	Monolithic	0.1	GRM40 F	
C3	Monolithic	0.001	GRM40	
C4	Monolithic	33P	GRM40	
C5	Monolithic	0.01	GRM40 F	
C6	Monolithic	0.01	GRM40 F	
C7	Monolithic	0.01	GRM40 F	
C8	Monolithic	0.1	GRM40 F	

EF UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	
C9	Monolithic	0.001	GRM40
C10	Monolithic	0.001	GRM40
C11	Monolithic	0.001	GRM40
C12	Monolithic	0.001	GRM40
C13	Monolithic	0.001	GRM40
C14	Monolithic	0.001	GRM40
C15	Monolithic	0.1	GRM40 F
J1	Connector	PD09A04M	
J2	Connector	PD09A02M	
J3	Connector	PD09A02M	
J4	Connector	PD09A03M	
J5	Connector	PD09A04M	
J6	Connector	PD09A05M	
J7	Connector	PD09A06M	
J8	Connector	PD09A02M	
J9	Connector	PD09A03M	
J10	Connector	PD09A02M	
J11	Connector	PD09A03M	
J12	Connector	TLB-P04H-B1	
J13	Connector	PD09A03M	
J14	Connector	TLB-P03H-B1	
J15	Connector	TLB-P03H-B1	
J16	Connector	PD09A02M	
J17	Connector	TLB-P03H-B1	
J18	Connector	8S-S-E	
P1	Connector	EHR-03	
P2	Connector	EHR-10	
P3	Connector	EHR-07	
P4	Connector	EHR-09	
P5	Connector	EHR-03	
P6	Connector	EHR-06	
P7	Connector	EHR-03	
P8	Connector	EHR-04	
P9	Connector	EHR-04	
DS1	LCD	LP234-A	
DS2	Lamp	HRS-7219A-G40	
DS3	Lamp	HRS-7219A-G40	
DS5	LED	GL9ND2	
S1	Rotary Encoder	SRBM1L011A	
S2	Switch	SKHLAB	064A
S3	Switch	SKHLAB	064A
S4	Switch	SKHLAB	064A
S5	Switch	SKHLAB	064A
S6	Switch	SKHLAB	064A
S7	Switch	SKHLAB	064A
S8	Switch	SKHLAB	064A
S9	Switch	SKHLAB	064A
S10	Switch	SKHLAB	064A
S11	Switch	SKHLAB	064A
SP1	Speaker	57S38-1	
EP1	P.C.B.	B-1138B	
EP2	P.C.B.	B-1140A	
EP3	P.C.B.	B-1229	
EP5	Rubber Conductor	SS TYPE	48.5×8.5×3
EP6	P.C.B.	B-1175B	

11 - 2 MAIN UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	
IC1	IC	MB87001P-G	
IC2	IC	MB504P-G	
IC3	IC	µA78L05AWC	
IC4	IC	µPD4094	(#01)
IC5	IC	S-7116A	(#01)
IC6	IC	SC-1019	
IC6	IC	SC-1022	(IC-28H version)
IC7	IC	µPC358C	
IC8	IC	NJM4558D	
Q1	Transistor	2SA1048-GR	
Q2	FET	2SK184-Y	
Q3	Transistor	2SA1048-GR	
Q4	Transistor	2SC2458-GR	
Q5	FET	2SK184-Y	
Q6	FET	2SK184-Y	
Q7	Transistor	2SC2458-GR	
Q9	FET	2SK125	
Q10	Transistor	2SC2026	
Q11	Transistor	2SC2458-GR	
Q12	Transistor	2SA1048-GR	
Q13	Transistor	2SC2026	
Q14	Transistor	2SC2458-GR	
Q16	Transistor	2SC2407	
Q16	Transistor	TRF559	(IC-28H version)
Q17	Transistor	2SA1359-Y	
Q17	Transistor	2SB1019-O/Y	(IC-28H version)
Q18	Transistor	2SC2458-GR	
Q18	Transistor	2SC1645-B	(IC-28H version)
Q19	Transistor	2SC2458L-G	
Q20	FET	2SJ105-GR	
Q21	Transistor	2SC3399	
Q22	Transistor	2SA1048-GR	
D1	Zener	RD15E B2	
D2	Diode	1SS133	
D3	Varicap	1SV50E	
D4	Varicap	1SV50E	
D5	Zener	RD30E B2	
D6	Diode	1S953	
D7	Diode	1SS216	
D8	Diode	1SS216	
D10	Diode	1SS133	
D11	Diode	1SS53	
D12	Diode	1SS97	
D13	Diode	1SS97	
D14	Diode	MI308	
D14	Diode	MI407	(IC-28H version)
D15	Diode	MI308	
D16	Diode	15CD11	
D17	Diode	1SS133	
D18	Zener	RD20E B2	
D21	Diode	1SS133	
D22	Diode	1SS133	
D23	Diode	1SS133	
D24	Diode	MI308	
D25	Diode	1SS133	
D27	Diode	1S953	(IC-28H version)
X1	Crystal	CR106	(#01, #04)
X1	Crystal	CR107	(#03, #05)
X2	Crystal	RF4A3FAANKD	(#01)
L1	Coil	LAL02KR 3R3K	

MAIN UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	
L2	Coil	LB-167	
L3	Coil	LAL02KR	3R3K
L5	Coil	LAL02KR	3R3K
L6	Coil	LR-116	
L7	Coil	LAL03NA	3R3K
L8	Coil	LA-244	
L9	Coil	LW-30	
L10	Coil	LAL03NA	102K
L13	Coil	LA-246	
L13	Coil	LA-254	(IC-28H version)
L14	Coil	LA-234	
L14	Coil	LA-244	(IC-28H version)
L15	Coil	LW-19	
L16	Coil	LA-235	
L17	Coil	LA-244	
L18	Coil	LA-236	
L19	Coil	LA-244	
L20	Coil	LW-19	
L21	Coil	LA-233	
L22	Coil	LA-233	
L22	Coil	LA-235	(IC-28H version)
L23	Coil	LA-235	
R1	Resistor	220k	ELR20
R2	Resistor	150k	ELR20
R3	Resistor	100k	ELR20
R4	Resistor	330k	ELR20
R5	Resistor	27k	ELR20
R6	Resistor	10k	ELR20
R7	Resistor	47k	ELR20
R8	Resistor	100k	ELR20
R9	Resistor	10k	ELR20
R10	Resistor	2.2M	ELR20
R11	Resistor	470	ELR20
R12	Resistor	270	R20
R13	Resistor	2.2k	ELR20
R14	Resistor	470	ELR20
R15	Resistor	2.7k	ELR20
R16	Resistor	470	ELR20
R17	Resistor	47	ELR20
R18	Resistor	47	ELR20
R19	Resistor	100	ELR20
R20	Resistor	4.7k	ELR20
R21	Resistor	680	ELR20
R22	Resistor	47	ELR20
R23	Resistor	220	ELR20
R24	Resistor	100	ELR20
R25	Resistor	47	ELR20
R26	Resistor	4.7k	ELR20
R27	Resistor	680	ELR20
R29	Resistor	47	ELR20
R30	Resistor	270	ELR20
R31	Resistor	18	ELR20
R32	Resistor	270	ELR20
R33	Resistor	4.7k	ELR20
R34	Resistor	4.7k	ELR20
R37	Resistor	270k	ELR20
R38	Resistor	100k	ELR20
R39	Resistor	470	ELR20
R40	Resistor	470	ELR20
R41	Resistor	10k	R20
R42	Resistor	15k	ELR20
R43	Resistor	68k	ELR20
R44	Resistor	2.2k	ELR20

MAIN UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)		
R45	Resistor	15k	ELR20	
R46	Resistor	47k	ELR20	(#01)
R47	Resistor	47k	ELR20	(#01)
R48	Trimmer	RHB0CS42BA	47k	(#01)
R49	Resistor	10	R20	(#01)
R50	Resistor	4.7k	R20	
R51	Resistor	1k	ELR20	
R52	Resistor	10k	ELR20	
R53	Resistor	10k	ELR20	
R54	Resistor	2.2k	R20	
R55	Resistor	390	R20	
R59	Resistor	2.2k	R20	
R60	Resistor	330	ELR20	(IC-28A/E versions only)
R61	Resistor	47	ELR20	
R62	Resistor	10	ELR20	(IC-28A/E versions only)
R63	Resistor	330	ELR20	
R63	Resistor	220	R50	(IC-28H version)
R64	Resistor	10k	ELR20	
R64	Resistor	33k	ELR20	(IC-28H version)
R65	Resistor	47k	ELR20	
R66	Resistor	10k	ELR20	
R67	Resistor	100	ELR20	
R68	Resistor	820k	ELR20	
R68	Resistor	2.2M	ELR20	(IC-28H version)
R69	Resistor	15k	ELR20	
R70	Resistor	1.2k	ELR20	
R70	Resistor	2.2k	ELR20	(IC-28H version)
R71	Trimmer	RHMOAJ304A		3.3k
R72	Trimmer	RHMOAJ305A		2.2k
R73	Resistor	390	ELR20	
R73	Resistor	47	ELR20	(IC-28H version)
R74	Resistor	56k	ELR20	
R75	Resistor	4.7k	ELR20	
R76	Resistor	100k	R20	
R77	Resistor	4.7k	R20	
R77	Resistor	4.7k	CRB25FX	(IC-28H version)
R78	Resistor	4.7k	R20	
R78	Resistor	4.7k	CRB25FX	(IC-28H version)
R79	Resistor	100	R50	
R79	Resistor	68	R50	(IC-28H version)
R80	Resistor	100	ELR20	
R81	Resistor	1k	ELR20	
R82	Resistor	5.6k	ELR20	
R83	Resistor	1.2M	ELR20	
R84	Resistor	100	ELR20	
R85	Resistor	220k	ELR20	
R86	Resistor	270k	ELR20	
R87	Resistor	100	ELR20	
R88	Resistor	1.5k	ELR20	
R89	Trimmer	RHB0C151XA		100k
R90	Resistor	56k	ELR20	
R91	Resistor	5.6k	ELR20	
R92	Resistor	100k	ELR20	
R93	Resistor	33k	ELR20	
R94	Resistor	100k	ELR20	
R95	Resistor	47k	ELR20	
R96	Resistor	150k	ELR20	
R97	Resistor	82k	ELR20	
R98	Resistor	82k	ELR20	
R99	Resistor	82k	ELR20	
R100	Trimmer	RHB0C1431A		10k
R101	Resistor	330	ELR20	

MAIN UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)		
R102	Resistor	220k	ELR20	
R103	Resistor	6.8k	ELR20	
R105	Resistor	100k	ELR20	(#01)
R106	Resistor	180k	ELR20	
R107	Resistor	680	ELR20	
R108	Resistor	1.2M	ELR20	
R109	Resistor	47k	R20	
R110	Resistor	100k	R20	
R111	Resistor	470k	ELR20	
R112	Resistor	10	R50X	(IC-28H version)
R113	Resistor	150	ELR20	(IC-28H version)
C1	Tantalum	DN1V	100M1S	
C2	Tantalum	DN1V	100M1S	
C3	Tantalum	DN1V	2R2M1S	
C4	Tantalum	DN1V	0R1M1S	
C5	Ceramic	470P	50V	
C6	Ceramic	470P	50V	
C7	Ceramic	0.001	50V	
C9	Ceramic	1P	50V	
C10	Ceramic	0.001	50V	
C11	Ceramic	1P	50V	
C12	Ceramic	470P	50V	
C13	Ceramic	100P	50V	
C14	Ceramic	470P	50V	
C15	Tantalum	DN1C	4R7M1S	
C17	Electrolytic	3.3	50V	MS7
C18	Electrolytic	3.3	50V	MS7
C19	Ceramic	100P	50V	
C20	Electrolytic	10	16V	MS7
C21	Ceramic	470P	50V	
C22	Ceramic	5P	50V	
C23	Ceramic	10P	50V	
C24	Ceramic	22P	50V	
C25	Ceramic	0.001	50V	
C26	Ceramic	0.001	50V	
C27	Ceramic	0.001	50V	
C28	Electrolytic	4.7	25V	MS7
C29	Ceramic	39P	50V	
C30	Ceramic	27P	50V	
C31	Trimmer	ECR-GA020E30		20P
C32	Barrier	0.1	16V	
C33	Electrolytic	22	6.3V	MS7
C34	Ceramic	470P	50V	
C35	Ceramic	470P	50V	
C36	Ceramic	470P	50V	
C37	Electrolytic	10	16V	MS7
C38	Ceramic	470P	50V	
C39	Electrolytic	4.7	25V	MS7
C40	Ceramic	470P	50V	
C46	Ceramic	12P	50V	
C46	Ceramic	47P	50V	(IC-28H version)
C47	Ceramic	470P	50V	
C48	Ceramic	470P	50V	
C49	Ceramic	470P	50V	
C50	Ceramic	470P	50V	(IC-28A/E versions only)
C51	Ceramic	470P	50V	(IC-28A/E versions only)
C52	Ceramic	22P	50V	
C53	Ceramic	10P	50V	(IC-28A/E versions only)
C54	Tantalum	DN1V	100M1S	
C55	Ceramic	0.001	50V	

MAIN UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)		
C56	Electrolytic	10	16V	MS7
C57	Ceramic	0.001	50V	
C58	Ceramic	0.001	50V	
C59	Ceramic	0.001	50V	
C60	Ceramic	0.001	50V	
C61	Electrolytic	10	16V	MS7
C62	Ceramic	0.001	50V	
C64	Ceramic	0.001	50V	
C65	Ceramic	22P	500V	
C65	Ceramic	12P	500V	(IC-28H version)
C66	Ceramic	1P	50V	
C66	Ceramic	2P	50V UJ	(IC-28H version)
C67	Ceramic	20P	50V	
C67	Ceramic	27P	50V CH	(IC-28H version)
C68	Ceramic	1P	50V	
C68	Ceramic	2P	50V UJ	(IC-28H version)
C69	Ceramic	20P	50V	
C69	Ceramic	27P	50V CH	(IC-28H version)
C70	Ceramic	12P	500V	
C71	Ceramic	0.001	50V	
C72	Ceramic	0.001	50V	
C73	Ceramic	0.001	500V	
C74	Ceramic	100P	50V	
C75	Ceramic	39P	50V	
C76	Ceramic	15P	500V	
C77	Ceramic	30P	500V	
C78	Ceramic	30P	500V	
C79	Ceramic	10P	500V	
C80	Ceramic	220P	50V	
C81	Barrier	0.01	25V	
C82	Ceramic	470P	50V	
C83	Tantalum	DN1A	100M1S	
C84	Barrier	0.01	25V	
C85	Electrolytic	4.7	25V	MS7
C86	Ceramic	470P	50V	
C87	Tantalum	DN1V	R22M1S	
C88	Ceramic	470P	50V	
C89	Electrolytic	1	50V	MS7
C90	Tantlum	DN1V	010M1S	
C91	Barrier	0.01	25V	
C92	Ceramic	470P	50V	
C93	Barrier	0.001	25V	
C94	Barrier	0.0022	25V	
C95	Ceramic	120P	50V	
C96	Ceramic	39P	50V	(#01)
C97	Ceramic	39P	50V	(#01)
C98	Electrolytic	0.1	50V	MS7 (#01)
C99	Barrier	0.01	25V	(#01)
C100	Ceramic	0.001	50V	(#01)
C101	Electrolytic	2.2	50V	MS7 (#01)
C102	Ceramic	0.001	50V	
C103	Ceramic	0.001	50V	(IC-28A/E versions only)
C104	Ceramic	470P	50V	
C105	Electrolytic	47	25V	MS9
C106	Ceramic	22P	500V	
C106	Ceramic	18P	500V	(IC-28H version)
C107	Ceramic	22P	50V	
C108	Ceramic	22P	50V	
C109	Ceramic	22P	50V	
C109	Ceramic	10P	50V	(IC-28H version)
C110	Ceramic	22P	50V	
C111	Ceramic	470P	50V	
C112	Feed Through	TF318-450E 102GMV	50V	

MAIN UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)		
C113	Ceramic	0.001	50V	
C114	Ceramic	20P	50V	
C115	Ceramic	470P	50V	
C115	Ceramic	2P	500V	(IC-28H version)
C116	Ceramic	2P	500V	(IC-28H version)
C117	Ceramic	220P	50V	(IC-28H version)
C118	Ceramic	0.001	50V	(IC-28H version)
J1	Connector	B03B-EH-S		
J2	Connector	B04B-EH-S		
J3	Connector	B04B-EH-S	(IC-28A/E versions only)	
J4	Connector	B10B-EH-S		
J5	Connector	B10B-EH-S		
J6	Connector	B08B-EH-S		
J7	Connector	TLB-P11H-B1		
J8	Connector	B03B-EH-S		
J9	Connector	B07B-EH-S		
J11	Connector	B04B-EH-S		
J12	Connector	B03B-EH-S	(IC-28H version)	
J13	Connector	B04B-EH-S	(IC-28H version)	
P1	Connector	TMP-P01X-A1		
P2	Connector	TMP-P01X-A1		
P3	Connector	EHR-09		
P4	Connector	EHR-03	(IC-28H version)	
EP1		OPC-90		
EP2		OPC-143		
EP3	P.C.B.	B-1136E		
EP3	P.C.B.	B-1250A	(IC-28H version)	
EP4	Ferrite Bead	DL2-OP2.6-3-1.2H		
EP5	Ferrite Bead	DL2-OP2.6-3-1.2H		
EP6	P.C.B.	B-1254	(IC-28H version)	
EP9	Crystal Seat	4124	(#01)	
MP3	VCO Case	42550		
MP4	VCO Case Cover	42551		
MP10	Filter Shield Case	43246		
W2		61/08/140/C31/W13A		
W3		61/99/170/C31/W13A	P2	
W17		JPW-02A		
W22		JPW-02A		

11 - 3 RX UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)	
IC1	IC	MC3357P	
IC2	IC	μPC1241H	
IC3	IC	MB3756	
IC4	IC	NJM4558D	
Q1	Transistor	2SC2668-O	
Q2	FET	2SK241-Y	
Q3	FET	2SK125	
Q4	Transistor	2SC3355	
Q5	Transistor	2SA1048-GR	
Q6	Transistor	2SC2458-GR	
Q7	Transistor	2SC2458-GR	
Q8	Transistor	2SC2458-GR	
Q9	Transistor	2SC2458-GR	
Q10	Transistor	2SA1348	
Q11	FET	2SJ105-GR	
Q12	Transistor	2SB909M-R	
Q13	Transistor	2SC2458-GR	
Q14	Transistor	2SC2458-GR	
Q16	Transistor	2SC3399	
Q17	Transistor	2SC3399	
Q18	Transistor	2SA1048-GR	
Q19	Transistor	2SD1225M-R	
D1	Zener	RD6.2E B2	
D2	Varicap	1SV50E	
D3	Varicap	1SV50E	
D4	Varicap	1SV50E	
D5	Diode	1S953	
D6	Diode	1SS216	
D7	Diode	1SS216	
D8	Diode	1SS216	
D9	Diode	1SS216	
D10	Diode	1S953	
D12	Diode	1S953	
D13	Diode	1S953	
D14	Diode	1S953	
D16	Diode	1SS133	
D17	Diode	1SS133	
D19	Diode	1S953	
D20	Diode	1SS133	
D21	Diode	1SS133	
D22	Diode	1SS133	
D24	Diode	R6.2E B2	
D25	Diode	1SS133	
D26	Diode	1SS133	
D27	Diode	1SS133	
FI1	Ceramic	CFV455E10	
FI2	Crystal	17M15B	
X1	Discriminator	CDB455C7A	
X2	Crystal	CR166	
L1	Coil	LS-66	
L2	Coil	LS-66	
L3	Coil	LS-171	
L4	Coil	S4	101k
L5	Coil	LS-209	
L6	Coil	LS-291	
L7	Coil	LS-291	
L8	Coil	LS-291	
L9	Coil	LA-235	
L10	Coil	LB-50A	

RX UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)		
L11	Coil	LB-50A		
L12	Coil	LAL03NA	3R3k	
L13	Coil	LA-244		
L14	Coil	LAL03NA	3R3k	
L15	Coil	LA-235		
L17	Coil	LA-245		
R1	Resistor	1.5k	ELR20	
R2	Resistor	47k	ELR20	
R3	Resistor	1.5k	ELR20	
R4	Resistor	1.5k	ELR20	
R5	Resistor	1k	ELR20	
R6	Resistor	56k	ELR20	
R7	Resistor	18k	ELR20	
R8	Resistor	22k	ELR20	
R9	Resistor	100	ELR20	
R10	Resistor	100	ELR20	
R11	Resistor	10k	ELR20	
R13	Resistor	2.2k	ELR20	
R14	Resistor	470	ELR20	
R15	Resistor	330	ELR20	
R16	Resistor	100	R20	
R17	Resistor	1.5k	ELR20	
R18	Resistor	1.5k	ELR20	
R19	Resistor	100k	ELR20	
R20	Resistor	100k	ELR20	
R21	Resistor	100k	ELR20	
R22	Resistor	68	ELR20	
R23	Resistor	470	ELR20	
R25	Resistor	820	ELR20	
R26	Resistor	120	ELR20	
R27	Resistor	3.3k	R20	
R28	Resistor	3.9k	ELR20	
R29	Resistor	12k	R20	
R30	Resistor	12k	R20	
R31	Resistor	3.9k	ELR20	
R32	Resistor	5.6k	ELR20	
R33	Resistor	330k	ELR20	
R35	Resistor	100k	ELR20	
R36	Resistor	100k	ELR20	
R37	Resistor	27k	R20	
R38	Resistor	180k	R20	
R39	Resistor	47k	R20	
R40	Resistor	100	R20	
R41	Trimmer	RHB0CS32UA		4.7k
R42	Resistor	2.7k	R20	
R43	Resistor	100k	ELR20	
R44	Resistor	47k	R20	
R45	Resistor	2.7k	ELR20	
R46	Resistor	1k	R20	
R48	Resistor	12k	R20	
R50	Resistor	10k	R20	
R51	Resistor	100k	ELR20	
R52	Resistor	27k	R20	
R53	Resistor	27k	R20	
R54	Resistor	68k	R20	
R55	Resistor	27k	R20	
R56	Resistor	22k	R20	
R57	Resistor	10k	R20	
R58	Resistor	470k	ELR20	
R59	Resistor	100	R20	
R60	Resistor	2.2	ELR20	
R61	Resistor	470	ELR20	
R62	Resistor	470	ELR20	

RX UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)		
R63	Resistor	27k	R20	
R64	Resistor	5.6k	ELR20	
R65	Resistor	12k	ELR20	
R66	Resistor	1.2M	ELR20	
R67	Resistor	1.2M	ELR20	
R68	Resistor	12k	ELR20	
R70	Resistor	100	ELR20	
R71	Resistor	2.7k	ELR20	
R72	Resistor	4.7k	ELR20	
R74	Resistor	10k	ELR20	
R77	Resistor	100	R50	
R78	Resistor	1.5k	ELR20	
R79	Resistor	2.7k	ELR20	
R80	Resistor	3.3k	ELR20	
R81	Resistor	8.2k	ELR20	
R82	Resistor	4.7k	ELR20	
R83	Resistor	220k	ELR20	
R85	Resistor	220k	ELR20	
R86	Resistor	1.5k	ELR20	
R87	Resistor	100	ELR20	
R88	Resistor	27k	ELR20	
R90	Resistor	220k	ELR20	
R94	Resistor	1	R20	
R95	Resistor	1	R20	
R96	Resistor	1	R20	
R97	Resistor	100k	ELR20	
R98	Resistor	100k	ELR20	
R99	Resistor	3.3	ELR20	
R100	Resistor	1k	ELR20	
R101	Resistor	47	ELR20	
R102	Resistor	4.7k	ELR20	
R103	Resistor	100k	ELR20	
R104	Resistor	1k	R20	
C1	Ceramic	82P	50V	
C2	Electrolytic	0.1	50V	MS7
C3	Electrolytic	4.7	25V	MS7
C4	Barrier	0.1	16V	
C6	Barrier	0.01	25V	
C7	Tantalum	DN1C	4R7M1S	
C8	Ceramic	0.001	50V	
C9	Ceramic	5P	50V	
C10	Ceramic	100P	50V	
C11	Ceramic	39P	50V	
C12	Barrier	0.01	25V	
C13	Barrier	0.01	25V	
C15	Ceramic	27P	50V	
C17	Ceramic	39P	50V	
C18	Ceramic	3P	50V	
C19	Ceramic	47P	50V	CH
C20	Ceramic	82P	50V	CH
C21	Ceramic	12P	50V	
C22	Ceramic	0.001	50V	
C23	Ceramic	9P	50V	
C24	Barrier	0.01	25V	
C25	Ceramic	0.001	50V	
C26	Barrier	0.01	25V	
C27	Ceramic	0.001	50V	
C29	Ceramic	1P	50V	
C30	Ceramic	10P	50V	
C31	Ceramic	0.35P	50V	
C32	Ceramic	1P	50V	
C33	Ceramic	10P	50V	
C34	Ceramic	0.001	50V	

RX UNIT

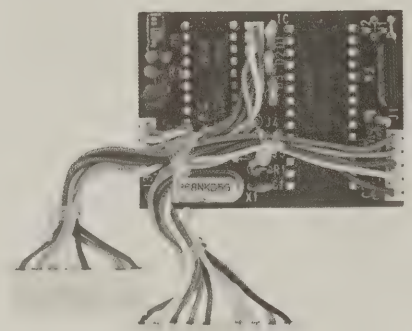
REF. NO.	DESCRIPTION	TYPE (PART NO.)		
C35	Ceramic	0.001	50V	
C36	Ceramic	0.001	50V	
C37	Ceramic	0.35P	50V	
C38	Ceramic	1P	50V	
C39	Ceramic	10P	50V	
C42	Ceramic	0.001	50V	
C43	Ceramic	22P	50V	
C44	Ceramic	22P	50V	
C45	Ceramic	470P	50V	
C46	Ceramic	0.001	50V	
C47	Ceramic	10P	50V	
C48	Ceramic	10P	50V	
C49	Ceramic	0.001	50V	
C50	Ceramic	18P	50V	
C51	Ceramic	470P	50V	
C52	Ceramic	22P	50V	
C53	Ceramic	22P	50V	
C54	Ceramic	0.001	50V	
C55	Ceramic	0.001	50V	
C56	Barrier	0.0015	25V	
C57	Ceramic	33P	50V	
C58	Barrier	0.0015	25V	
C59	Barrier	0.01	25V	
C61	Electrolytic	1	50V	MS7
C62	Ceramic	100P	50V	
C63	Barrier	0.01	25V	
C64	Barrier	0.01	25V	
C65	Barrier	0.01	25V	
C66	Barrier	0.01	25V	
C67	Electrolytic	1	50V	MS7
C68	Electrolytic	10	16V	MS7
C69	Barrier	0.01	25V	
C70	Ceramic	0.001	50V	
C71	Ceramic	0.001	50V	
C72	Ceramic	0.001	50V	
C73	Electrolytic	1	50V	MS7
C74	Ceramic	0.001	50V	
C75	Electrolytic	10	16V	MS7
C76	Ceramic	0.001	50V	
C77	Ceramic	470P	50V	
C78	Electrolytic	0.1	50V	MS7
C79	Electrolytic	47	16V	MS9
C80	Electrolytic	220	16V	MS9
C81	Barrier	0.1	16V	
C82	Electrolytic	47	16V	MS9
C83	Electrolytic	220	16V	MS9
C84	Electrolytic	470	16V	MS16
C85	Barrier	0.1	16V	
C86	Electrolytic	10	16V	MS7
C87	Electorlytic	4.7	25V	MS7
C88	Barrier	0.1	16V	
C89	Barrier	0.1	16V	
C90	Barrier	0.1	16V	
C92	Ceramic	0.001	50V	
C94	Ceramic	0.001	50V	
C95	Ceramic	0.001	50V	
C96	Barrier	0.01	25V	
C97	Barrier	0.01	25V	
C98	Electrolytic	10	16V	MS7
C99	Barrier	0.01	25V	
C100	Barrier	0.01	25V	
C101	Barrier	0.0047	25V	
C102	Mylar	0.056	50V	
C103	Ceramic	0.001	50V	

RX UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)			
C104	Electrolytic	1	50V	MS7	
C106	Ceramic	0.001	50V		
C108	Ceramic	56P	50V		
C109	Ceramic	0.001	50V		
C110	Electrolytic	4.7	25V	MS7	
C111	Electrolytic	0.1	50V	MS7	
C112	Barrier	0.01	25V		
C113	Electrolytic	10	16V	MS7	
C114	Electrolytic	0.33	50V	MS7	
C115	Electrolytic	4.7	25V	MS7	
C116	Ceramic	0.001	50V		
C117	Ceramic	470P	50V		
C118	Ceramic	0.001	50V		
C119	Ceramic	0.001	50V		
C120	Tantalum	DN1V	0R1M1S		
J1	Connector	IMSA-9201B-2-02-T			
J2	Connector	IMP-J01X-A2			
J3	Connector	IMP-J01X-A2			
J4	Connector	B9B-EH-S			
J5	Connector	B3B-EH-S			
J6	Connector	HSJ0836-001-010			
J7	Connector	B6B-EH-S			
J8	Connector	B9B-EH-S			
S1	Switch	SPPH21127A			
BT1	Lithium Battery	BR2032-1T2			
EP1	P.C.B.	B-1196D			
EP2	P.C.B.	B-1141B			
EP3	Crystal Seat	41424			
EP4	Filter Spacer	41590			
MP1	Helical Cavity	No.5	41053		
MP1	Helical Cavity	No.12	41053		(IC-28H version)
MP2	Helical Cavity	No.5	41053		
MP2	Helical Cavity	No.12	41053		(IC-28H version)
MP3	AF Amp Heat Sink	(1)-1	43313		
W1		JPW-02A			
W2		JPW-02A			
W3	JUMPER	74/98/015/X98/X98			
W4		JPW-02A			

12 - 1 UT-28, UT-29 OPTIONS

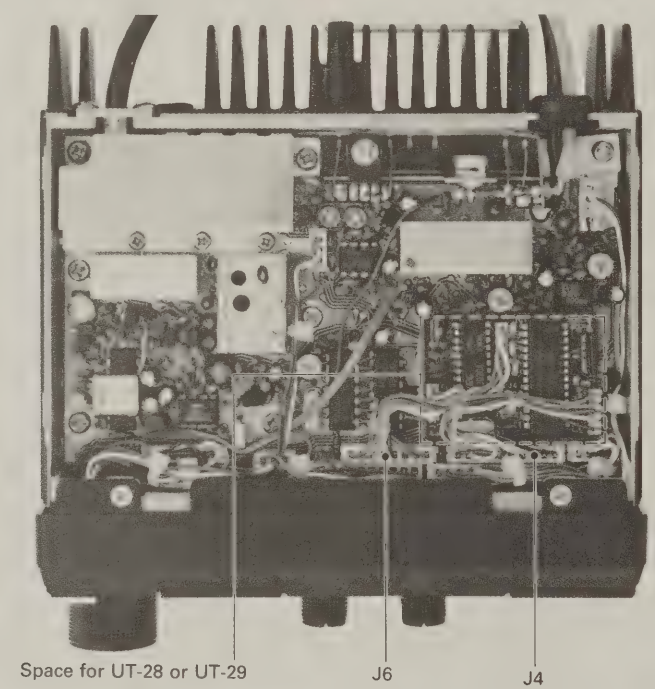
UT-28 DIGITAL CODE SQUELCH UNIT



UT-29 TONE SQUELCH UNIT

INSTALLATION PROCEDURE

Installation location on MAIN UNIT for UT-28 and UT-29.

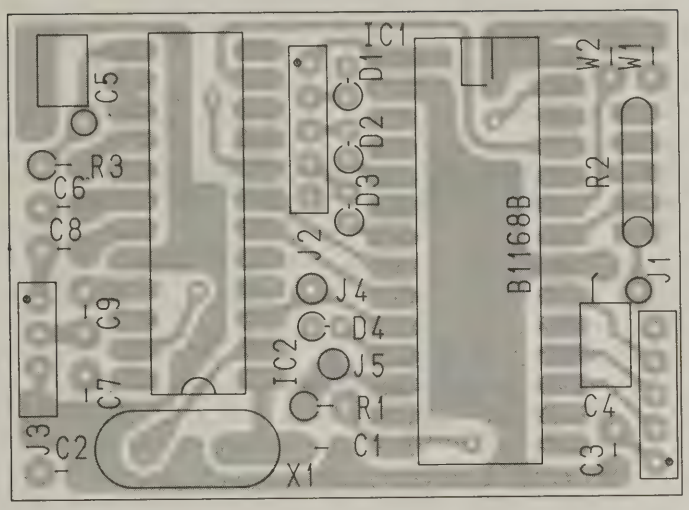


NOTE: Unplug the power cable before performing any work on the transceiver.

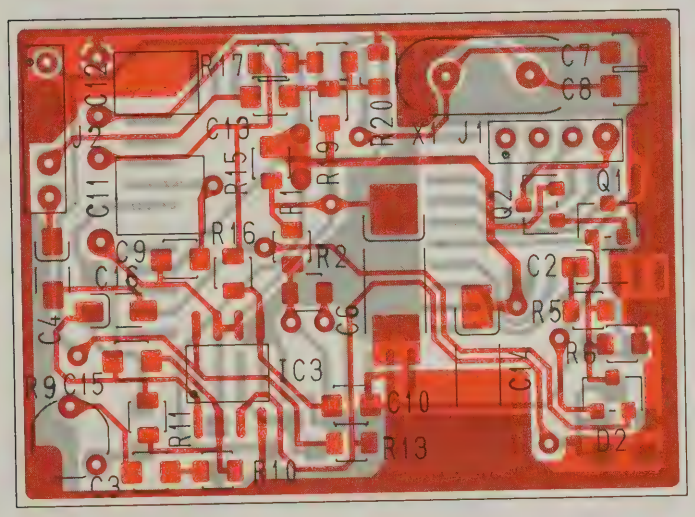
1. Unscrew the two cover screws on the rear panel and remove the top cover.
2. Connect the 10-pin and 8-pin plugs to J4 and J6 on the MAIN UNIT of the IC-28A/E/H.
3. Install the unit in the spot shown in the photo above.
   - Adhesive tape is applied to the sponge on the back of the unit, so remove this in order to install the unit properly.
4. Re-attach the cover to the transceiver.

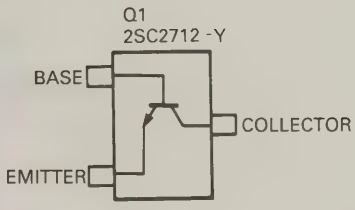
12 - 2 UT-28, UT-29 BOARD LAYOUTS

UT-28

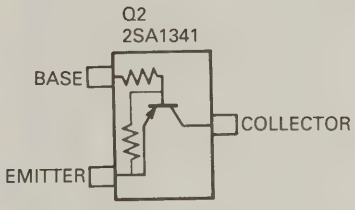


UT-29
(Top View)



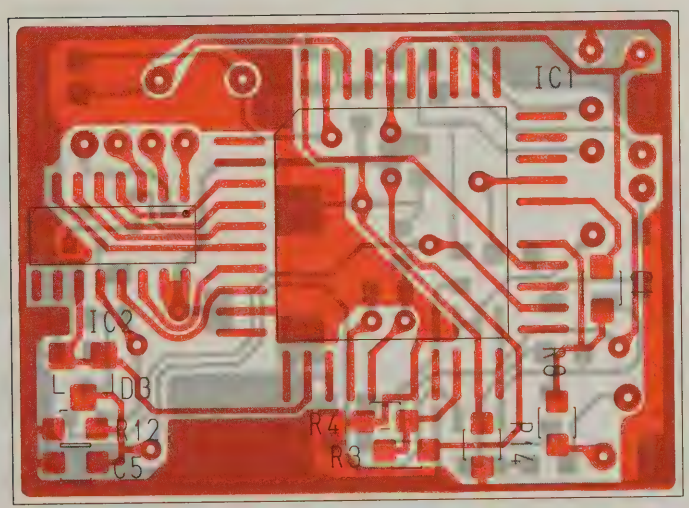


Symbol: LY

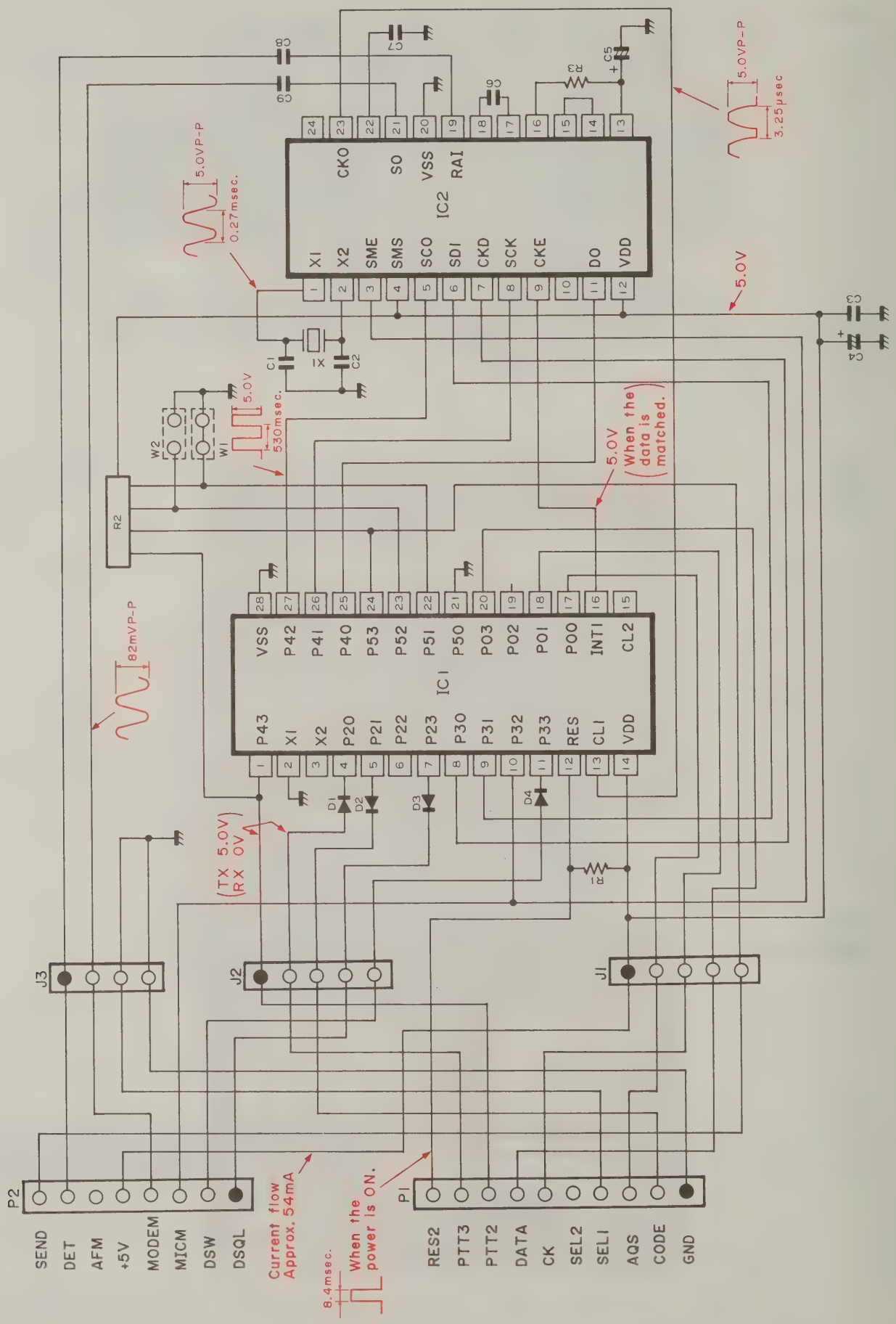


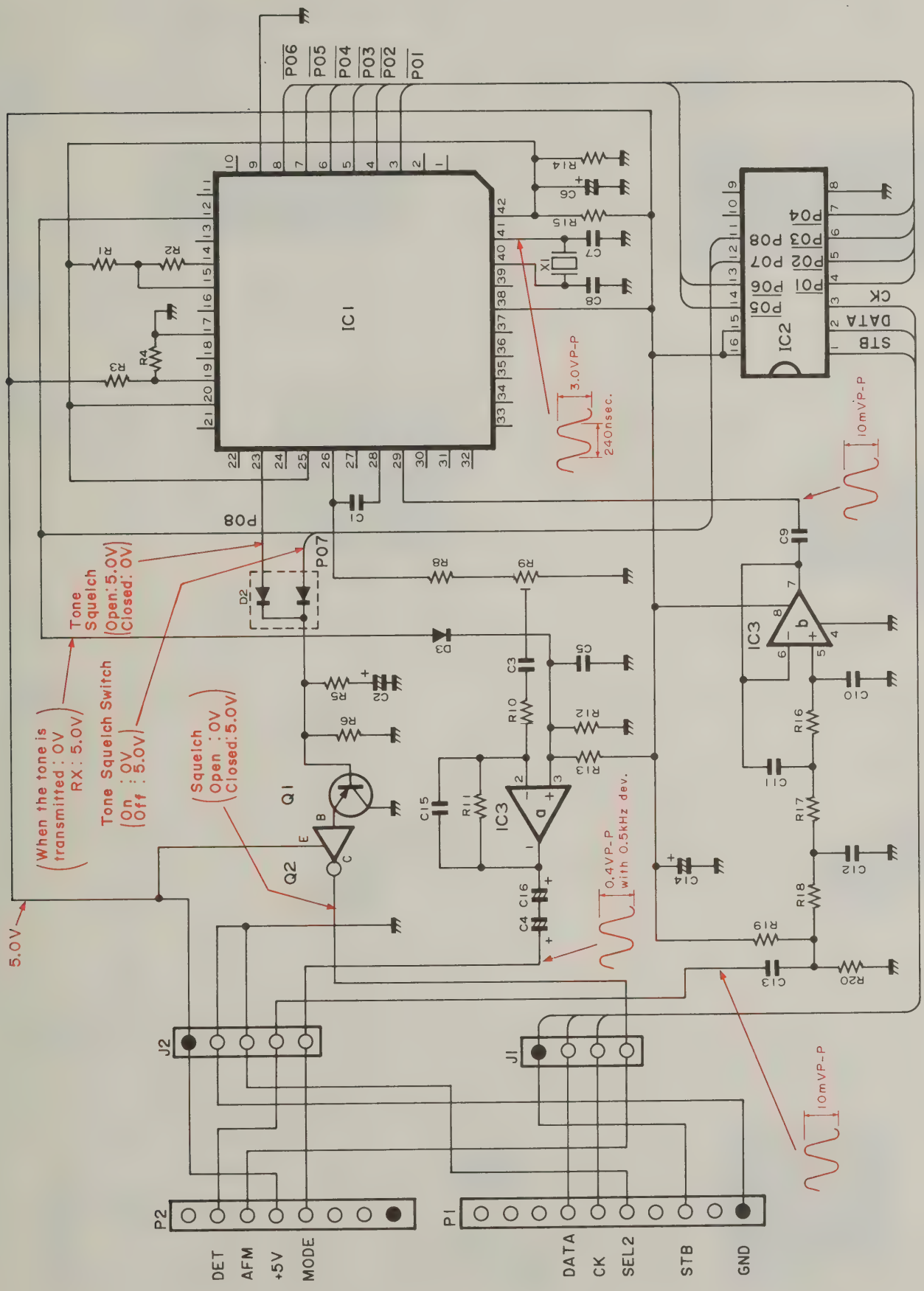
Symbol: BL

UT-29
(Bottom View)



12 - 3 UT-28 VOLTAGE/CIRCUIT DIAGRAM




P06
P05
P04
P03
P02
P01
IC1
IC2
P04
P08
P07
P05
P06
P01
P02
P07
P03
P08
CK
DATA
STB
3.0VP-P
240nsec.
10mVP-P
Tone Squelch (Open: 5.0V Closed: 0V)
Tone Squelch Switch (On : 0V Off : 5.0V)
(When the tone is transmitted : 0V RX : 5.0V)
Squelch (Open : 0V Closed: 5.0V)
Q1
Q2
IC3
0.4VP-P with 0.5kHz dev.
5.0V
J2
J1
P2
P1
DET
AFM
+5V
MODE
DATA
CK
SEL2
STB
GND

12 - 5 UT-28, UT-29 PARTS LIST

UT-28 DIGITAL SQUELCH UNIT

REF. NO.	DESCRIPTION	TYPE (PART NO.)		
IC1	IC	µPD7507SCT-217		
IC2	IC	µPD6302CA		
D1	Diode	1SS133		
D2	Diode	1SS133		
D3	Diode	1SS133		
D4	Diode	1SS133		
X1	Crystal	FABNKD00		
R1	Resistor	27k	ELR20	
R2	Array	RNSA05S473J		
R3	Resistor	27k	ELR20	
C1	Ceramic	33P	50V	
C2	Ceramic	33P	50V	
C3	Monolithic	D33Y5V1E104Z21		
C4	Electrolytic	4.7	25V	MS5
C5	Electrolytic	4.7	25V	MS5
C6	Barrier	0.01	25V	
C7	Monolithic	D33Y5V1E104Z21		
C8	Monolithic	D33Y5V1E104Z21		
C9	Monolithic	D33Y5V1E104Z21		
J1	Connector	PD09-05M		
J2	Connector	PD09-05M		
J3	Connector	PD09-04M		
P1	Connector	EHR-10		
P2	Connector	EHR-08		
EP1	P.C.B.	B-1168A		

UT-29 TONE SQUELCH UNIT

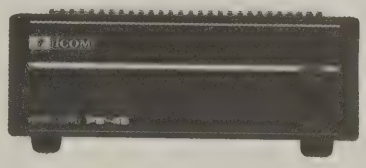
REF. NO.	DESCRIPTION	TYPE (PART NO.)	
IC1	IC	MN6520	
IC2	IC	µPD4094BG	
IC3	IC	NJM4558M	
Q1	Transistor	2SC2712-Y	
Q2	Transistor	2SA1341	
D2	Diode	1SS184	
D3	Diode	1SS193	
X1	Crystal	4.194304M	FACNKDOO
R1	Chip	2.2k	MCR10
R2	Chip	150k	MCR10
R3	Chip	10k	MCR10
R4	Chip	15k	MCR10
R5	Chip	10k	MCR10
R6	Chip	470k	MCR10
R8	Chip	4.7k	MCR10
R9	Trimmer	10k	RH0521C14J08A
R10	Chip	180k	MCR10
R11	Chip	820k	MCR10
R12	Chip	100k	MCR10
R13	Chip	100k	MCR10
R14	Chip	10k	MCR10
R15	Chip	10k	MCR10
R16	Chip	330k	MCR10
R17	Chip	330k	MCR10
R18	Chip	330k	MCR10
R19	Chip	1M	MCR10
R20	Chip	1M	MCR10
C1	Monolithic	0.1	GRM40 F
C2	Tantalum	1µ	SVA1C105M
C3	Monolithic	0.1	GRM40 F
C4	Tantalum	1µ	SVA1C105M
C5	Monolithic	0.1	GRM40 F
C6	Tantalum	68µ	SVD0G686M
C7	Monolithic	18P	GRM40
C8	Monolithic	18P	GRM40
C9	Monolithic	0.1	GRM40 F
C10	Monolithic	82P	GRM40
C11	Mylar	0.039	50V
C12	Mylar	0.0047	50V
C13	Monolithic	0.1	GRM40 F
C14	Tantalum	10µ	SVC1C106M
C15	Monolithic	270P	GRM40
C16	Tantalum	1µ	SVA1C105M
J1	Connector	PD09A-04M	
J2	Connector	PD09A-05M	
P1	Connector	EHR-10	
P2	Connector	EHR-08	
EP1	P.C.B.	B-1197A	

12 - 6 OTHER OPTIONAL UNITS

Part of the tremendous versatility in the IC-28A/E/H is its adaptability to base station use when not being used as a mobile unit.

The following recommended options will help complement your new base station system.

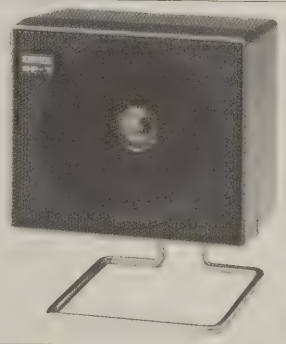
PS-45 POWER SUPPLY
(For use with the IC-28A/E)



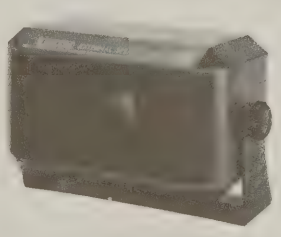
The OPC-102 INTERFACE CABLE for connecting the PC-45 to the IC-28A/E must be purchased separately.

IC-PS30 AC POWER SUPPLY
(For use with the IC-28H)

SP-7 EXTERNAL SPEAKER
- Compact, easily installed in a variety of locations
- Adjustable, light-weight stand

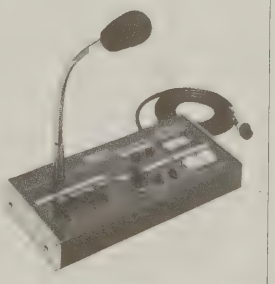


SP-10 EXTERNAL SPEAKER
- Adjustable stand for multi-directional audio output
- Excellent also for mobile use



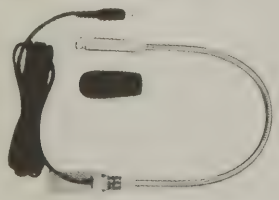
SM-8 DESK MICROPHONE
- Electret condenser type mic element
- UP/DOWN function switches
- Tone control
- HIGH/LOW mic output select-ability

SM-10 COMPRESSOR/GRAPHIC EQUALIZER DESK TOP MICROPHONE
- Electret condenser mic element
- Compressor amplifier
- Tunable equalizer
- Level meter and Output level control
- UP/DOWN function switches

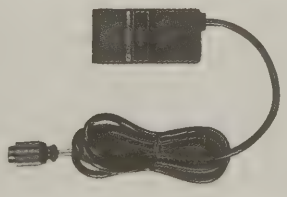


AND FOR MOBILE USE:

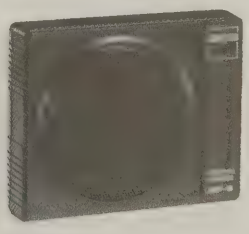
HS-15 MOBILE FLEXIBLE MICROPHONE
- Uni-directional mic
- Flexible neck
- Light, convenient for driving ease

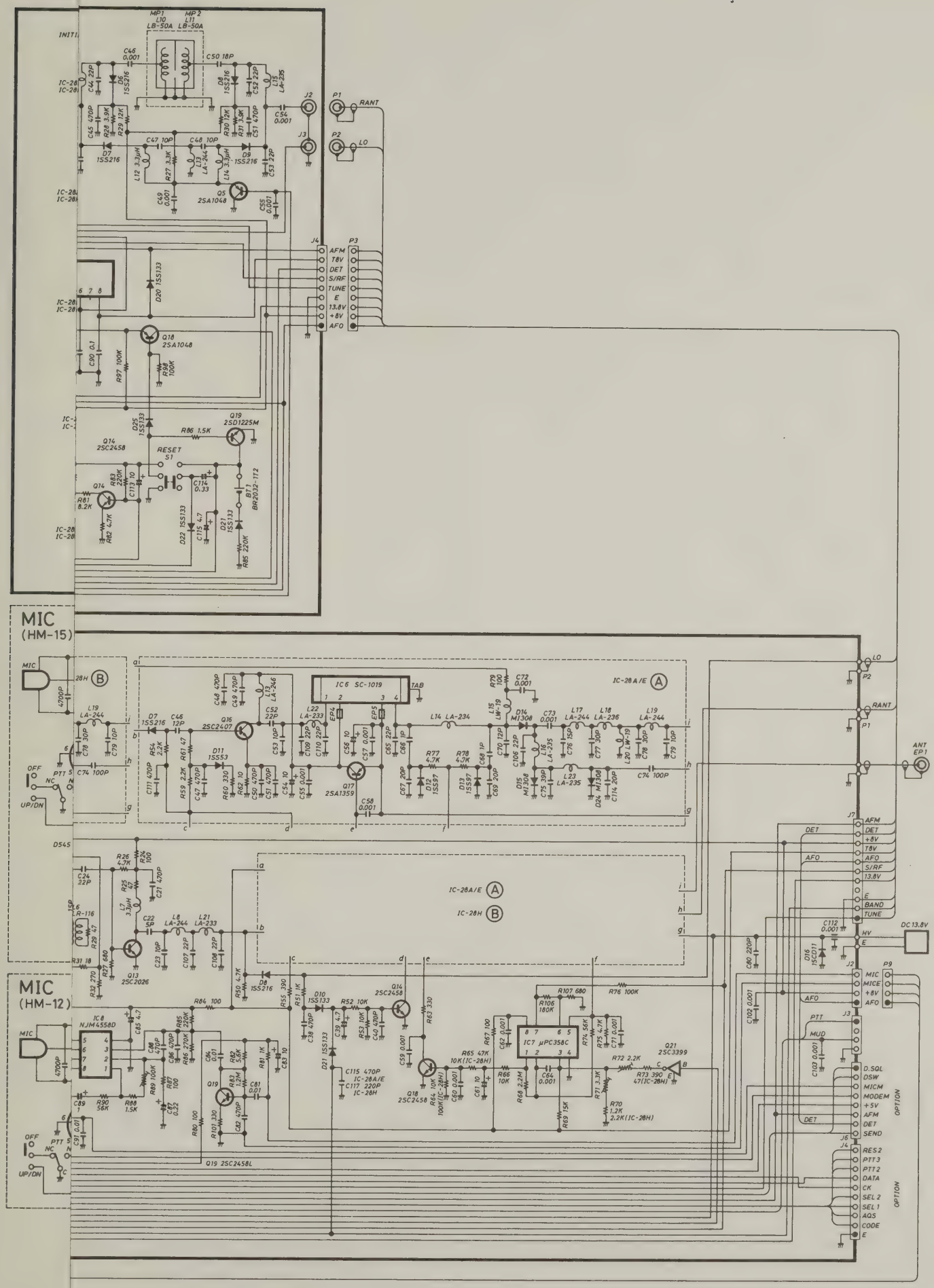


HS-15SB SWITCHBOX
- Connects to the HS-15



SP-8 EXTERNAL MOBILE SPEAKER
- Compact, easily attachable to your sun visor or dashboard





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To upgrade quality, some components may be subject to change without notice.

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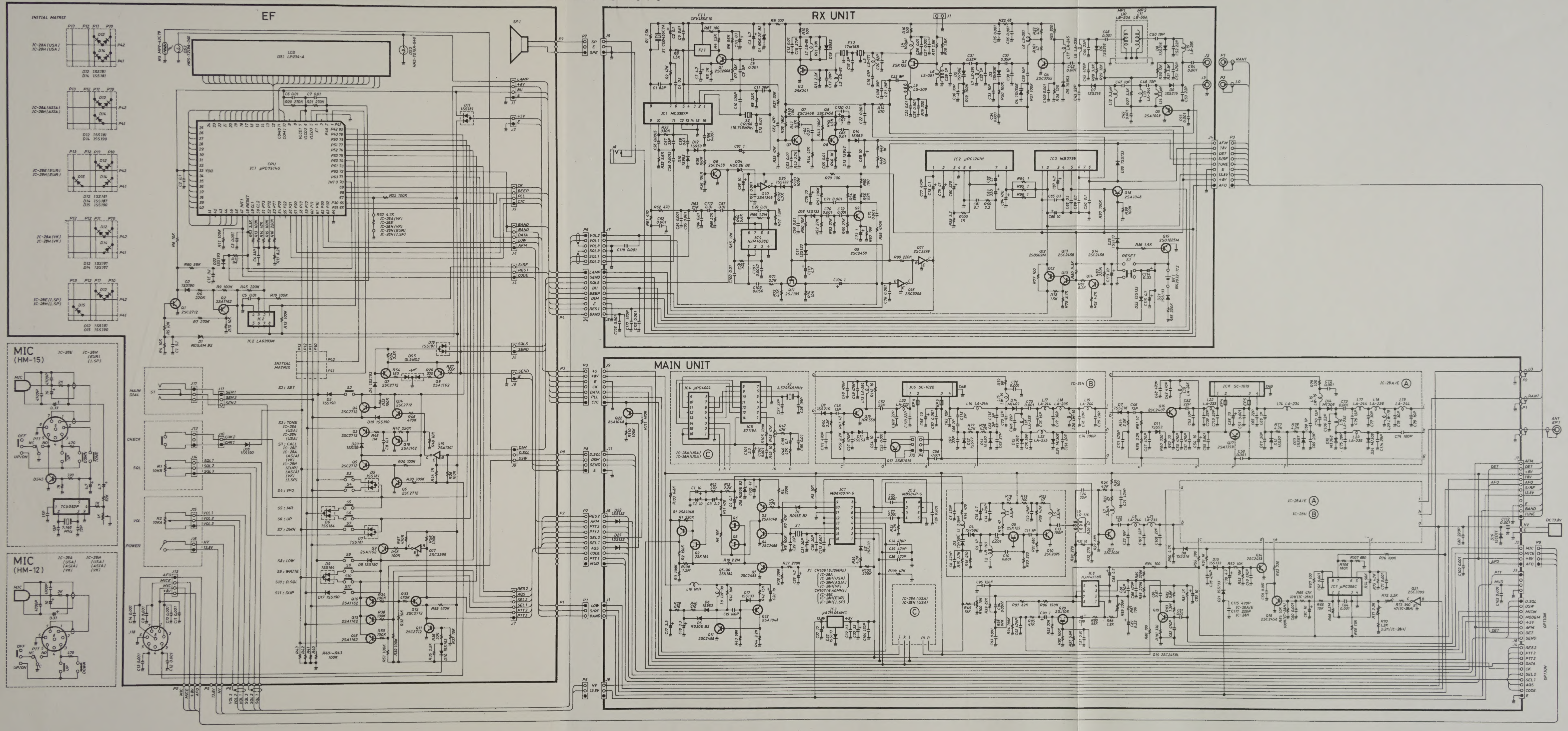
IC-28A/E/H SCHEMATIC DIAGRAM



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To upgrade quality, some components may be subject to change without notice.

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